ELECTRICAL REVIEW

ILLUSTRATED.

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VIEWS, NEWS AND INTERVIEWS.

"I would like no better fun," said an electrical engineer and inventor, "than to equip 50 miles of railway with electric locomotives which appear to me in my mind's eye like this: They have drivers seven feet in diameter, an armature between each pair of drivers five feet in diameter and four feet long; and the rest of the space filled in solidly with iron which gives over 100,000 lines of force to the square inch."

"A weak point in the London underground electric road," remarked Mr. Stephen D. Field, "is, to my mind, the placing of the armatures on the wheel axles of the locomotives. Running at a speed of 20 miles an hour the blow delivered on the wheel, axle and armature by passing over so much as a grain of sand is equivalent to the blow of a large steam trip hammer."

The contractors have assured Col. Dan Lamont that cars will be running on the Broadway cable road by September 1. He says there is no truth in the report that electricity will be used in place of the cable.

A well known electrical supply man says that in the early days, his company received a circular from an electrical instrument manufacturing firm, telling of the merits of their products. One prominent claim was that "the contacts are all made of *chemically pure brass*." The supply man's partner remarked: "The fellow who wrote that circular would talk about a mule's pedigree."

Herman Hollerith, the inventor of the electric tabulating machine with which the totals of the census of 1890 were summed up, is a statistician as well as an electrician, and has made census work a special study for several years.

Nelson E. Swartwout, formerly of Chicago, died by his own hand at New Orleans, January 19th. From 1876 to 1884 he was private secretary to Prof. Elisha Gray, and through this connection became well known in the electrical field. In 1884 he was made secretary of the old Sectional Underground Conduit Company, which office he held until Professor Gray gave up the management of the affairs of the company, in 1887. He leaves a wife and a daughter who reside in New York.

Hotel men, theatre managers, manufacturers and others who use the incandescent electric light extensively, still complain of the cost of lamps. This in face of the fact that one of the leading companies has reduced the price to 40 cents each, for 16 candle power lamps if bought in large lots. Experimental lamps have been made in private laboratories which are marvels in efficiency and life, but the great expense and care required in making them prevents their being a success in the commercial sense. Is not the average lamp, say one used in a hotel, broken long before its maximum life has been reached? Would it not be wise to sacrifice the life of a lamp used for such purposes, and, if possible, cheapen the cost of producing it?

Crocker-Wheeler Electric Pumps.

Of the desirability and advantages of the electric pump, little need be said, for its application was one of the first uses suggested by electric motors, yet, strangely enough, it has been among the last problems successfully solved. In the combination here illustrated, all cumbersome, expensive and disagreeable features of the gas, oil or hot air pumping engines are displaced by a neat and durable motor, driving a new type of suction and force pump specially built for this purpose.

By means of these outfits, pumping is done automatically and cheaply, by the power from the electric light wires, without noise, dust, ashes, attendance, dangers, odors, etc. These outfits are available for use in place of all other devices for pumping, where connection with the electric light wires may be secured. The cost of running at the full power continuously is very small, being for the ½ horse-power outfits from one to three dollars per month. By an automatic attachment to the ordinary float in the tank, the current is shut off as soon as the tank is filled, and started again when partially empty, thereby saving the expense of current supply when water is not drawn. This prevents the tank from ever becoming entirely empty, and proportions the current consumed to the water used.

The pump is especially designed for use with high speed electric motors for continuous and heavy service in raising water to considerable heights through pipes. It raises the water in a steady and uniform volume, with entire absence of that pounding or "water hammer" accompanying the use of common pumps, so disagreeable to the ear and destructive to plumbing. It is provided with noiseless raw hide pinion and back gearing to reduce the speed, and give sufficient power to the pump to work under high pressures, thus making it capable of raising water from 50 feet to 300 feet vertically, without injury or undue wear to any of the parts.

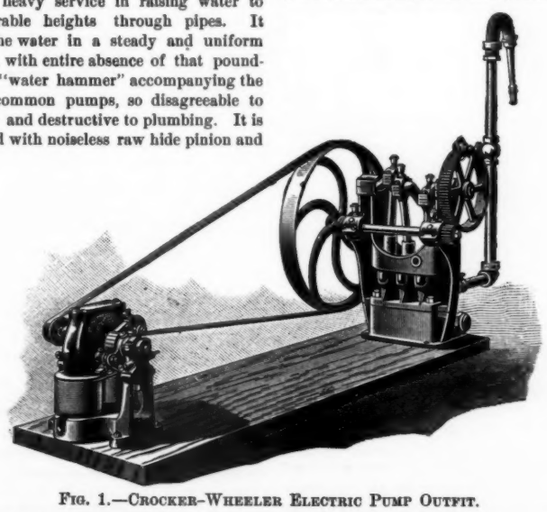


Fig. 1.—Crocker-Wheeler Electric Pump Outfit.

The motors are of the latest, most durable and efficient design, being the result of experience obtained in the manufacture and use of many thousand machines. They are of sufficient power to run the pumps for any height of pumping lift, and are wound for either arc or incandescent electric light circuits.

The outfit illustrated is a sample of the smallest size, and shows that the Crocker-Wheeler Company makes even the smallest combinations complete in every detail. This size is capable of lifting 500 gallons of water per day a height of 100 feet, and other quantities a correspondingly greater or less height.

The larger outfits are used extensively,

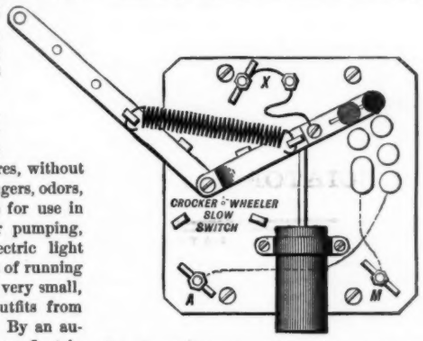


Fig. 2.—Automatic Tank Switch for Crocker-Wheeler Electric Pumps.

and are suitable for filling tanks in large houses, hotels, clubs, etc., for supplying hydraulic elevators, large tanks for factories, fire purposes, etc.

The company also fits up other styles of pumps of lighter construction with their motors, where such heavy duty is not required, furnishing either rotary, centrifugal or single and double cylinder suction and force pumps, connected with motors of the proper size to operate them at full power. The capacity of these outfits is from two to four times greater than the regular style, but they are not suitable for very high lifts.

Resentenced to Electrocution.

Harris A. Smiler, who killed his wife nearly a year ago and was tried and convicted last June, was sentenced last week by Judge Fitzgerald to die by electricity during the week beginning August 4 last. Smiler's counsel took an appeal, pending which there was a stay of execution.

Early Experiments With Permanent Magnets.

To the Editor of Electrical Review:

The article entitled "A Magnetic Paradox," giving an extract from an address by Prof. Sylvanus Thompson, in the last number of the Review, January 31, reminds me of some experiments with permanent magnets, made by me in Washington, in February, 1867, almost exactly 24 years ago.

The magnets were of the ordinary horseshoe form and were made of cast steel, about ⅜x1¼ inch in section and weighed 2.4 pounds each. The soft iron keeper was of the same thickness as the magnets and about one inch wide.

After charging the magnets so that they would sustain something more than their own weight, it was found that when the keeper was so placed that it covered only one-sixth of the face of the poles, it would sustain more than double the weight that it would hold when placed squarely over the entire face of the poles.

There were four of the magnets and the results were as follows: Average weight sustained by each, when the keeper was flush with the magnets, three pounds; when the keeper covered only one-sixth of the face of the poles the average weight sustained was 6.8 pounds.

In all cases the pull was direct and the weight was steadily increased until the keeper dropped.

It will be noticed that the magnets were not very highly charged. Placing the four magnets together, like the leaves of a wagon spring, and placing the keeper upon one of the interior magnets it sustained 20 pounds, whereas the sum of the weights sustained by the four magnets separately was only 12 pounds, as already stated.

A smaller horseshoe magnet weighing only 3.8 ounces sustained 15.2 ounces, when the keeper was flush and 24¾ ounces when it was covering only a small portion of the face of the poles.

This great increase in strength appears to exist only when the keeper is in contact with the poles and practically disappears when they are separated only by the thickness of a sheet of letter paper.

Very respectfully, yours,
W. R. King,
Lt. Col. Engrs.

Willets Point, Whitestone, N. Y., Feb. 3.

Rapid Transit at the Electric Club.

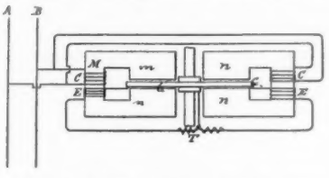
The next regular meeting of the New York Electric Club will be held at the Club house, 17 East Twenty-second street, on Thursday evening, February 26th. A dinner to cost three dollars a plate, exclusive of wines, will be served promptly at 6.30. Members desiring to be present at the dinner, must notify the secretary on or before February 23d, in order that provision may be made for the comfort of all. As only about 100 can be seated at the table, the privilege of inviting guests will have to be suspended on this occasion. Applications for the privilege may, however, be made to the secretary, and will be granted in the order of their receipt as far as the accommodations of the Club will permit.

The topic for discussion at this meeting will be "Rapid Transit for New York City." It is expected that a number of prominent men actively interested in street railway work in various parts of the country, will be present as guests of the Club and participate in the discussion.

PROGRESSIVE ELECTRICAL INVENTIONS.

ALTERNATING CURRENT MOTOR.

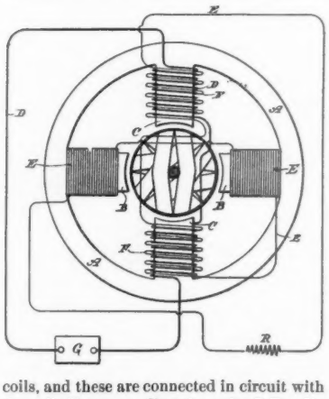
An alternating current motor involving the principle of the Faraday disk has been designed by Messrs. Billberg and Winand, of Philadelphia. One form of construction adopted by the gentlemen is illustrated in the accompanying engraving, in which A and B illustrate two alternating current mains and M a field-magnet carrying a coil connected with the mains. Upon the magnet is wound a secondary coil E, the terminals of which connect with brushes bearing on the periphery and center of a disk G composed of radial laminar iron strips or bars. By properly proportioning the primary and secondary windings of the field-magnet M,



which in effect constitutes a transformer, currents of great volume can be caused to circulate through the secondary circuit, and thence by brushes set at different circumferential positions around the disk through the radial bars which make up said disk, thus giving considerable torque to the armature. The induced current passing radially through all of the bars constituting the disk G, from circumference to center or *vice versa*, creates a torque which is the sum of the attractive efforts of all the bars in circuit, thus multiplying the torque which would be exerted if the current followed only a single path through the field of force.

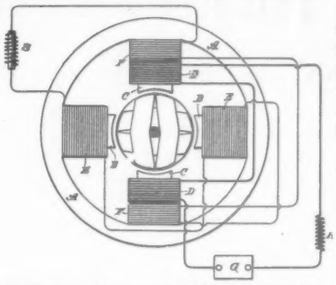
ALTERNATING CURRENT MOTORS.

We illustrate in the accompanying engravings an improvement in alternating current motors devised by Nikola Tesla, whose previous work in this line of invention has frequently been referred to by the REVIEW. In the present instance Mr. Tesla operates his motor from a single alternating circuit, the motor itself creating a lagging set of waves which co-operate with the waves of the main circuit in developing rotary motion. The invention as illustrated comprises a laminated field magnet, A, provided with four pole-pieces, B C B C, two of which are placed in the main alternating circuit and are diametrically opposed to each other, and the other two are placed in a secondary circuit in which current is induced by the primary. On the same poles which contain the primary coils, D, are wound secondary coils, F, either side by side or over or under the primary



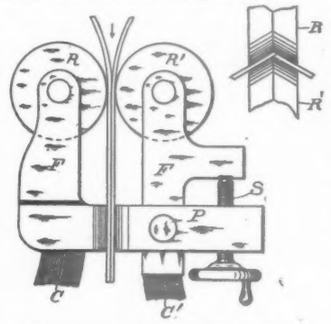
coils, and these are connected in circuit with the coils E surrounding the poles B B. To secure a proper difference in phase between the primary and secondary currents, Mr. Tesla increases the resistance of the secondary circuit and makes its self-induction as low as practicable by using for such circuit wire of comparatively small diameter, and having but few turns around the cores, or by introducing at some point of the secondary circuit an artificial resistance R. The current generated in the secondary coil reacts upon the primary current, modifying the extent of retardation of such current behind the impressed electromotive force, according to the amount of self-induction and resistance in the secondary circuit. If the secondary circuit have but little self-induction it will increase the difference of phase between its own and the primary current by diminishing the lag between the primary current and the impressed electromotive force, and also by reason of its own lag or retardation behind the impressed electromotive force.

The system of winding referred to, aims to keep down the self-induction and increase the resistance in the secondary circuit so as



to decrease the amount of lag between the impressed electromotive force and the current in the primary coils, and increase the difference of phase between the primary and secondary currents.

If the secondary circuit have a high self-induction, its lag behind the current in the primary is directly increased, while it will be still further increased if the primary have very low self-induction. An organization of apparatus by which this alternative plan of creating a difference in time-period between the primary and secondary waves is adopted, see the second diagram, where the primary coils B have a low self-induction and a high resistance, while the secondary coils E F have a high self-induction and low resistance. This may be done by proper winding of the coils, or by introducing in the secondary circuit a self-induction coil S, and a dead resistance R in the primary circuit. In both cases, G illustrates diagramatically a source of alternating current.



IMPROVEMENTS IN ELECTRIC WELDING.

Several patents have recently been granted to Elihu Thomson for improvement in welding apparatus, one of which is illustrated in the accompanying engraving. It comprises two rotary electrodes R R^1, one of which is suitably insulated from the supporting base, to which electrodes a current of large heating volume is led by means of the brushes C C^1. Suitable means, as the screw indicated, are provided for throwing the rollers into closer or more remote adjustment. The two pieces of metal which are to be welded in a continuous line, are introduced between the electrodes and fed gradually forward, the weld being produced by the heat developed in the strips as they move between the rolls. These strips are indicated in the engraving. By making the rolls of suitable section, various conformations may be given to the product of the welding operation, one design of the invention being to produce tubes or pipes having a continuously welded seam. In the detached view is shown a number of rollers for producing a weld between two pieces of metal, resulting in a trough having a V-shape in cross-section.

Professor Thomson has also patented a method of welding involving the idea of gradually or suddenly throwing on a current capable if continued of heating the pieces to be welded beyond the necessary temperature, and then, before such temperature is reached, diminishing the current with the effect of preventing overheating or too rapid heating. In some cases the resistance during the welding operation rapidly rises and as the amount of heat developed is in proportion to the resistance, danger of burning is incurred. In order to avoid this the pieces to be welded when placed in the clamps and pressed into good contact have the current admitted suddenly in a large amount, causing a rapid accumulation of heat at the joint, and when the welding temperature is nearly reached, the current is diminished by means of a core suddenly thrust into a coil in the primary circuit, thus choking off part of the primary current and reducing the strength of current in the welding circuit.

Another invention of Professor Thomson's consists in maintaining at the holding clamps, or at the point where current enters the work, an alternating current of fairly uniform potential so as to produce a gradual heating of the work automatically through a gradual increase of resistance due to rise of temperature. The primary circuit is supplied with an alternating current of uniform character as to potential, so that as the resistance at the joint varies by reason of the increasing heat, the strength of current will be lowered and danger of overheating obviated.

Special Train to Providence.

The committee on transportation announce that to accommodate delegates going from and through New York to the ensuing meeting of the National Electric Light Association at Providence, R. I., they have arranged for a train of parlor buffet cars to leave the Grand Central Depot, New York, on Monday, February 16th, at 1 P. M., arriving in Providence at 6:15 P. M.

Applications for seats must be made to Gen. C. H. Barney, 20 Cortlandt street, this city, previous to 6 P. M. on Friday, 13th inst., accompanied by a remittance of $1.00 for each seat desired. This is imperative, as the necessary cars will be ordered on Saturday. Seats will be allotted in the order in which applications are received.

For the convenience of New York delegates desiring tickets on the certificate plan, and to avoid a rush at the station, a representative of the railroad company will be at the Electric Club, 17 East Twenty-second street, New York city, on Saturday, 14th inst., at 8 P. M., to deliver tickets and issue certificates.

The single railroad fare from New York to Providence will be $4.30; the return fare, if a certificate is obtained, will be $1.44; making the round trip cost $5.74. An extra charge of $1.00 for each parlor car seat will be made. General Barney will furnish any further information desired.

The Latest Figures.

Whipple's Reports for February, 1891, furnish us the following information:

CENTRAL STATION COMPANIES.

Stations in United States	1,560
" Canada	120
" Cuba	1
" Mexico	10
Total Stations	1,691

GAS COMPANIES.

Companies in United States	971
" Canada	49
" Mexico	1
Total	1,021
Companies operating Electric Lights, U. S.	281
" " " " Canada	20
" " " " Mexico	1
Total	302

STREET RAILWAY COMPANIES.

Companies in United States	919
" Canada	25
Total	944
Electric Roads in Operation and under Contract in United States	285
Electric Roads in Operation and under Contract in Canada	6
Total	291
Cable Roads in the United States	47

The Dog Wags The Tail.

The man who observed that the large rivers generally happened to run close to the large cities has now discovered that the firms that do the largest amount of business generally happen to have the largest advertisements in the papers.—*Dansville, N. Y., Breeze.*

GENERAL BUSINESS NOTES.

The American Steel Car Wheel Company, Boston, has on exhibition at its offices in the New England Building, the largest steel car wheel ever cast in New England. It is 36 inches in diameter, and is a magnificent sample wheel. It is without a flaw or blemish, and there is not the slightest indication of blow holes or porocity. Although this sample wheel is much larger than is required for street railway service, yet it is made on the same principle as the company's ordinary steel wheels.

Holmes, Booth & Haydens, the well-known wire manufacturers, are receiving many strong testimonials of the excellent behavior of their wires during the recent storm. The following is an extract from letter received from the Bristol Electric Light and Power Company:

BRISTOL, PA., Jan. 29, 1891.
Messrs. HOLMES, BOOTH & HAYDENS, New York.

GENTLEMEN: "All our K. K. lines withstood the storm of Saturday night. In two instances telephone wires rested across the mains without short circuiting us, and a number of such wires depended from our lines to the ground without showing any ground at the station. In fact, we have never had a break or ground on your wire, and hope that we never may."

Very truly yours,
(Signed) CHARLES E. SCOTT, Treasurer.

W. R. Fleming & Company, selling agents for the Harrisburg, Ide and Ideal engines, boilers, etc., seem to be getting their full share of electric steam plant installations. Their claim to establish a leading business in these lines on reliable and conservative engineering work seems to be well founded. During the past two weeks contracts have been made for the following plants: Messrs. Koch & Company, New York, one 90 horse-power and one 60 horse-power Ideal engine; Mt. St. Vincent, Central Park, one 20 horse-power Ideal; Heisler Electric Light Company, for town of Union, 200 horse-power Ide cross compound, with boiler and complete steam plant; Penna. Club House, Long Branch, 40 horse-power Ideal complete steam plant. Several smaller orders taken make an aggregate of a trifle over 600 horse-power during the two weeks.

The Ongley Electric Company, 1 Broadway, New York, are in receipt of the following interesting communication:

PHILADELPHIA FIRE UNDERWRITERS' ASSOCIATION, 136 and 138 So. 4th St., PHILADELPHIA, Feb. 4, 1891.

JOHN E. WHITING, Secretary.
W. A. PORTER, Supt. Surveys.
The Ongley Electric Company, No 1 Broadway, N. Y.

Gentlemen—At a meeting of the executive committee of this association, held this day, the following resolution was adopted, viz.:

Resolved, That the Ongley Electric Register and Safety Signal system having been fully investigated by officials of this association, we hereby cordially approve of the same; and we will accept it as a satisfactory watch clock in mills or other places where the rules of the association call for such protection.

Yours very truly,
(Signed) JOHN E. WHITING, *Secretary.*

The Interior Conduit and Insulation Company, 16 to 18 Broad street, New York, write us as follows:

Inasmuch as our interior conduits are being largely used for purposes for which they were not designed, we have been compelled to carefully compile a set of specifications for the purpose of enabling architects, builders and owners to intelligently comprehend the many advantages enjoyed by our system, and to call for bids upon their work with the full assurance that they will secure all the advantages of our system. We will request all to whom we may send these specifications, in the interest of themselves, their clients and our own good repute, to make no changes in these specifications without the courtesy of an inquiry of us as to what their effect will be. We assure them that we will either approve the changes suggested or give convincing reasons for not doing so. We trust that these specifications will be the means of securing better, safer and more thoroughly satisfactory electric light wiring for the ever-increasing number of patrons of the art.

An Electrical Trust Company as a Means of Placing Electrical Securities on a Higher Plane.

About ten years ago, when the electrical industry was just getting fairly started on its triumphal career of progress, unhealthy speculation in electrical inventions and securities was rife. As more solid financial men became interested in electrical manufacturing, the speculative tendency decreased and new money making schemes were kept well within the charmed circle. Sounder business methods were adopted with the naturally resulting beneficial effects.

This leaning toward speculation in the early days has been gradually reformed.

The early impressions gained by financial writers both in this country and Europe lead them to criticise severely what they are pleased to term "the speculative nature of the electrical industry."

Realizing how important a question of the hour this matter has become, it was thought that the opinions of one well informed as to electrical securities would be interesting to the readers of the ELECTRICAL REVIEW. Mr. Franck Z. Maguire, who has made electrical securities a special study, was found at his office, 18 Wall street, this city, and consented to tell the REVIEW his ideas on the subject.

"The electrical business would be greatly facilitated," said Mr. Maguire, "if a trust company could be formed which would make a specialty of handling electrical securities and passing upon the safety of electrical investments or purchasing them outright if they chose to do so. There is no reason that these securities should be put upon the market at a very low rate, when the prospects for paying dividends and principal are good. If a trust company could be formed with a directory of men prominent in financial and electrical matters, the prospect of success is far beyond the ordinary."

"At what figure would you capitalize such a trust company?"

"Well, $500,000 cash to start on; preferably, $1,000,000, full paid."

"Would not securities in which your board might already be interested be apt to influence the rating of new securities brought before them to pass upon?"

"Allegiance to any one company would have to be sacrificed and the value of the security in a commercial sense would be alone considered by the board. Most all the prominent electrical companies have a large amount of securities on hand which are not marketable. Ruinous competition has been indulged in at times, and over capitalization has been a very serious evil. The tendency of an electrical security trust company would be to put an end to a great extent to both these evils."

"In what way?"

"Because such a company being known as the headquarters for electrical investments and information concerning securities, could, by refusing to recommend stocks and bonds on which there was little or no prospect of making money, prevent their issue.

"To-day banks that would be glad to invest in electrical securities if they knew the prospect of return was good, turn the investment down, simply because they have nowhere to go for information concerning the bonds, except, perhaps, by the employment of experts, which they do not care to do. The reports of experts could not place bonds on the favorable basis that a trust company could by recommendation. There is no reason for slaughtering electrical bonds. To be forced to sell a bond at 50 or 60 that is worth 95, is a great detriment to the electrical business and generally leads to the inferior construction of plants."

"What would be the method of conducting business employed by such a trust company?"

"Let us suppose that a small town desires to put in an electric light plant. The demand is good for the light and the security is first-class. The promoter would bring the proposition for the placement of the bonds before the board, and the bonds would either be taken by the trust company, or, if they could not make it convenient to take up the investment, would recommend it to some bank. These bonds having the approval of a recognized authority, would consequently be easily marketed. Now, another company comes along, and supposing that the town of which I have spoken is not large enough to support two electric light companies, an attempt is made to float the bonds of the second enterprise. The bonds are, for instance, offered to a bank. The natural thing for a bank to do would be to make inquiry of the trust company as to the value of the investment offered. The trust company knowing that another electric light company in the town would not be successful, do not recommend the investment. As a result, the bonds are not floated, and ruinous competition is thereby prevented.

"Another feature which is most important and is likely to bring a large revenue to a trust company, is the banking feature which would be a part of the company's business."

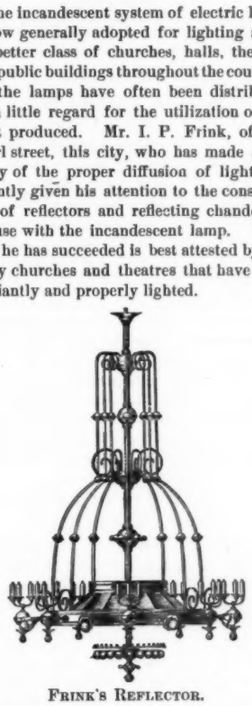
"Do you think electrical men would patronize such a bank?"

"As it is estimated that $700,000,000 is invested in the electrical business there can be no doubt of its ability to support a bank. Accommodations, with good electrical security, which could not be secured at a bank whose officers know nothing of the electrical business, could be obtained and electrical people would be glad to patronize it.

"It may be some time before such a trust company is established," said Mr. Maguire, in conclusion, "but to me it is the solution of the problem of putting electrical securities on their proper plane and I shall be more than happy to see it brought about."

Frink's Reflector.

The incandescent system of electric lights is now generally adopted for lighting all of the better class of churches, halls, theatres and public buildings throughout the country, but the lamps have often been distributed with little regard for the utilization of the light produced. Mr. I. P. Frink, of 551 Pearl street, this city, who has made a life study of the proper diffusion of light, has recently given his attention to the construction of reflectors and reflecting chandeliers for use with the incandescent lamp. How well he has succeeded is best attested by the many churches and theatres that have been brilliantly and properly lighted.



FRINK'S REFLECTOR.

We illustrate in this issue one of his latest fixtures—a combination gas and electric reflecting chandelier of ornate design, suitable for lighting the larger and finer class of assembly rooms. They are made in sizes from 72 to 106 inches in diameter, with from 51 to 90 gas burners, and 34 to 60 incandescent lamps. This fixture has a reflector incorporated in its construction in such a manner that its appearance is graceful, and the lights being placed both underneath and outside of it, the illumination is both general and effective.

Mr. Frink manufactures reflectors for every conceivable use, including the lighting of art galleries and for use on center poles in electric street railway construction.

Telegraph Poles in Mexico.

There are at least three distinct climates—that of the Tierra Fria, or Cold Land, up in the mountains; that of the Tierra Templada, Temperate Land, on the plateau, and extending down the slope toward the coast a few score miles; and, lastly, that of the Tierra Caliente, or Hot Land, which takes in the coast of the Pacific and Atlantic sides with also some of the sloping country. Thus remarks *Railroad Topics.*

The Tierra Templada is at the north of the country, characterized by the vast treeless plains, over which must be hauled by railway or by cart, where the railway does not penetrate, the poles and wire for the lines. Oftentimes great loads of poles, cut in the forest around Toluca or Paizcuaro, in the southern part of the republic, have to be slowly and laboriously hauled over the hot plains of Chihuahua and put in place by men who carry their rations for days with them. The cost of the poles and the wire is necessarily greatly enhanced by the transportation, and it may be said that telegraph wire, placed almost anywhere in Mexico, costs the government three times what it did landed at Vera Cruz or Paso del Norte.

Travelers on horseback in Northern Mexico traversing these vast, treeless and melancholy plains stop at night for camp, and finding the telegraph poles accessible and admirably seasoned, cut them down for firewood, and this is not all. The humble rancher, desiring a stock of wire with which to fence in an enclosure, goes with his peon servants and cuts down a mile or two for use, leaving poles oftentimes prostrate. I have myself seen poles wireless, and also long stretches of wire without poles.

And the poles brought so far at so great an expense have other enemies besides man. There is the insignificant looking worm, the "jengen," which insidiously honeycombs the poles till some fine day they fall at the breath of a breeze, strewing fragments of wood over the ground. This is a formidable opponent of telegraph communication in Mexico, and any bright American who can show how to keep it out of the poles may fairly demand a reward from the Mexican Government.

"I los pajaros son enemigos tambien" (and the birds are also enemies). There is a Mexican woodpecker who sits up toward the top of the pole and pecks and pecks for whole days, till the top comes off, and wires and cross-arms go, too. A great rogue is this Mexican woodpecker, the sworn enemy of telegraph poles. The linemen (celadores) shoot him when they can, but of what use? One dies and 40 comes after to the funeral.

And then the white ants, those industrious, unseen, hollowers-out of timber! These tiny creatures will eat out the inside of a pole till it is a mere shell, solid apparently, sturdy seemingly, but absolutely as good for nothing as an eggshell. Up comes the wind, and the poles blow away as if they were hornets' nests detached by a cyclone. These "hormigas blancas" dig out the inside of house timbers in some parts of the country. They have even been known to so hollow out the legs of a dining table that one day down it came with all its crockery and the noonday meal, too. The "hormiga blanca" is also the sworn enemy of civilization and progress as represented by the telegraph.

But the Hot Land has its enemies of telegraph also. How Mayne Reid or Ballantyne or Verne would have seized on the facts here represented: Picture to yourselves, good friends, a country of impenetrable vegetation, with gigantic palms and plantains, with jungles so dense that it is hard work with a stout and sharp machete to make a path through them, a country of intense heat, of innumerable mosquitoes and ticks and malaria and snakes, and vegetation that grows up in a day to a height that interferes with the labor of man.

Such are some parts of the Mexican States at Tabasco and Yucatan, and it is through such regions that the telegraph which connects the Mexican capitol with important points like San Juan Baptista or San Cristobal must penetrate. This is a country where the linemen go in couples, and armed with rifles to fight off the fierce puma or Mexican tiger (tigre) who assaults man and is especially ravenous for telegraph constructors. The Mexican linemen down in the hot coast country shoot many a puma while out attending their lines.

A scarcely less formidable antagonist is found in the monkey tribe which inhabits the jungles and chaparral of Tabasco. Literally, "the woods are full of them." Their favorite diversion, when not in quest of food, is to betake themselves to the telegraph line for gymnastic exercises, and linemen assert that often 100 able-bodied monkeys may be seen swinging on the wire, festooned, monkey fashion, by looping their tails. The continuous vibration of these forest gymnasts starts the iron nails used on the cross arms, and these often come down, bringing the wire with them.

And it is not a safe matter to undertake to disperse these robust monkeys who play the dickens with the telegraph lines in the sparsely inhabited State of Tabasco. Linemen have found that on shooting a monkey swinging on the wire, they have been pursued by a whole regiment of monkeys. "It is no joke (no esebroma)," said a lineman, recently, "to have a tribe of monkeys pursue one. They are very strong (muy fuertes) and can hit with a stone or stick in a fashion to make a man howl with pain, a thing the monkeys enjoy hugely."

In the coast country, especially on the Gulf of Mexico side, the wires, from the humid condition of the air, oxidize rapidly, and a wire is found by experience to be in need of replacement in a year's time. This adds heavily to the cost of keeping up the service.

Still another difficulty in maintaining a good service in the Hot Land States, is the impossibility of acclimating, in many regions, telegraph operators from the colder table lands. They easily fall a prey to fevers, and, if they escape with their lives, they have been absent from their posts and the service has suffered. So it has been found necessary to make use of natives of those regions, often imperfectly educated, and from whom much must be borne, perforce, for they make blunders with fatal facility and try the patience of the City of Mexico officers to a degree.

Kane, Pa.—Kane electric light company; capital, $5,000.

Olean, N. Y.—New York Postal Telegraph Company; capital, $4,000.

Oak Cliff, Tex.—Oak Cliff Light and Power Company; capital, $50,000.

New York City.—The Thermo-Electric Battery Company; capital, $30,000.

Hoboken, N. J.—Moore Electrical Manufacturing Company; capital, $25,000.

Washington, Ill.—The Sun Electric Light and Power Company; capital, $12,000.

Elkhart, Ind.—C. G. Conn Electric Manufacturing Company; capital, $5,000.

Maywood, Ill.—Maywood and Proviso Electric Light and Power Company; capital, $20,000.

Jersey City, N. J.—The Thomas Murray Company, to construct electrical machinery; capital, $100,000.

Yonkers, N. Y.—The Eickemeyer-Field Company, to manufacture and sell electrical railway equipments; capital, $1,000,000.

Atlantic City, N. J.—Electrical Amusement Company, to erect electrical machinery and devices for entertainment; capital, $50,000.

Chicago, Ill.—The Chicago Electric Motor Company, to manufacture electric motors, dynamos, etc.; capital, $250,000. Incorporators, Barron D. Southard, James H. Dean and Edward A. Manship.

Chicago, Ill.—Vibro Telegraph Company, to manufacture telegraph instruments, build and operate telegraph lines; capital, $1,000,000. Incorporators, William E. Sloan, John E. Hughes and Orrin S. Reed.

Chicago, Ill.—Day Electrical Construction Company, to manufacture electric motors, dynamos, etc.; capital, $1,000,000. Incorporators, Edwin F. Getchell, Leroy D. Thompson and Norman L. Ross.

Chicago, Ill.—Western Electrical Supply Company, to manufacture and deal in electrical supplies, etc.; capital, $30,000. Incorporators, William H. McKinlock, William Alton, Jr., and John McKinlock.

Bridgeport, Conn.—The Union Electric Manufacturing Company was organized recently at Bridgeport, Conn., for the purpose of manufacturing electrical specialties and novelties. Messrs. J. M. Orford, John English and H. T. Clark are among the promoters of the new enterprise.

Denver, Colo.—The Cache La Poudre Telephone Company has been incorporated, the directors being Joseph S. McClelland, Franklin C. Avery, Stephen A. Bradfield, Joel E. Davis and Benjamin H. Eaton. The capital of the company is placed at $6,000. The proposed line will extend from Greeley to Chamber's Lake in Weld and Larimer counties.

Annual Meeting of the Crocker-Wheeler Electric Motor Company.

At the annual meeting of this company, held at their office, 430 West Fourteenth street, on January 7, 1891, the following officers and directors were elected for the ensuing year: S. S. Wheeler, president; F. B. Crocker, vice-president; H. H. Crocker, treasurer, and R. N. Peterson, A. F. Higgins, Wm. B. Baldwin, A. K. Sloan, David Crocker, directors.

The annual sworn statement showed a full paid capital of $100,000, while the total indebtedness was less than $9,000, consisting only of the ordinary open monthly accounts. The statement showed that the business of the company had about doubled in each quarter year.

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Greetings to the thirteenth convention of the National Electric Light Association.

The recent holocausts in the mines of western Pennsylvania will lead to the presenting of a bill to the legislature requiring all mines in the State to be illuminated by incandescent electric lights.

The World's Fair Building Committee is trying to decide upon the best means of conveying people and material from the city proper to Jackson Park during the Fair. That's an easy problem. Answer: An electric railway.

Compare the quick, sure and humane execution of Eyraud, the French strangler, with the slow, torturing and diabolical killing of Kemmler at Auburn last year. The guillotine is a successful instrument of death to be used on murderers. Repeal the electrical execution law!

This issue of the ELECTRICAL REVIEW will be ready for you to read on your arrival at the Narragansett Hotel. Members of the REVIEW staff will be present during the sessions of the convention. Anything they can do for you will be a pleasure to them.

The cable tells us that the first Emperor William's rooms in his palace at Berlin have been photographed. For this purpose the electric light was introduced. The photographs represent the rooms exactly as the old emperor had them during his lifetime, and are said to be good.

The Electric Club, of this city, ought to invite the rapid transit commissioners to a dinner, and take the opportunity to fill their minds full of the good things that can be said about electric underground railways.—*New York Commercial Advertiser.*

It's all arranged and will occur February 26. Particulars are given in another place in this issue.

A bill has been introduced in the New York House which will practically abolish the Board of Electrical Control. The bill provides that the commissioners of the sinking fund shall have supervision over the electrical wires and railways of the city. The political advantages or disadvantages of such a bill are questionable and intricate. Viewed from an electrical standpoint, the only apparent gain would be the retirement of three figureheads, utterly devoid of intelligence regarding electrical matters. Whether the commissioners of the sinking fund are any better qualified to deal with the vexatious electrical tangles which evolve themselves in this city is an open question. To the mind of any intelligent man, it is evident that the electrical affairs of a city should be under the supervision of electrical experts.

A GEOLOGICAL ELECTRICAL ILLUMINANT.

The erygmatoscope is an instrument designed by M. Trouve for the examination of geological strata pierced by deep boring. The apparatus consists simply of a powerful electric incandescent lamp, enclosed in a cylindrical case, one of the curved sides of which serves as a reflector, while the other, made of thick glass, permits the illumination of the bore hole. An elliptical mirror, set at the bottom of the case, throws its images vertically upward through the open top of the case to the observer, who examines them with a powerful telescope. It is said that the apparatus works satisfactorily "to a depth of 1,000 feet," and that the Portuguese government supplied it to its Mozambique expedition.

THE UNITED STATES PATENT OFFICE.

According to the last annual report of the Commissioner of Patents, the number of applications for patents, registration of trade marks and labels, was greater during the last fiscal year than at any time within the history of the patent office. This means that the patent office made larger profits than ever. The commissioner again enters a plea for more room and better office equipment. Congress has so often turned a deaf ear to the petitions of the patent office that it will probably ignore Commissioner Mitchell's recommendations from sheer force of habit. There is no good reason why the Government should wax fat at the expense of the poor inventor—the contributions to the general prosperity of the nation due to inventors are great enough in other respects. The surplus millions of hard-earned dollars to the credit of the patent fund in the United States Treasury, should be expended in providing the office with facilities for doing business quickly and well. The theory of the patent law is that the government grants the inventor a monopoly for a short period for the sake of eventually acquiring for its citizens the usufruct, not to create a revenue from a tax on brains; this being the case, the inventor has a right to demand that any excess of receipts over expenditures at the patent office should be considered as trust funds and expended for his betterment. After that is done the fees should be lowered to a point where the inventor need pay only the average cost of the proceedings prescribed by law for the issuance of a patent.

RADIANT MATTER.

The paper of Professor Crookes upon radiant matter, presented in this issue of the REVIEW, contains a very able discussion of a very interesting subject. Professor Crookes has spent years in carefully investigating the action of electricity upon gases in vacua. The luminous condition of non-conducting materials when subjected to a molecular bombardment of attenuated gases is a very interesting phenomenon, and suggests possibilities of practical value. It leads one to speculate upon some such method of producing artificial light for domestic and commercial uses. Perhaps the light of the future will be sustained by a modified Holtz machine or an inductorium discharging through *ultra-gaseous* matter. The familiar light of the Geissler tube, with its soft and beautiful radiance, is a phenomenon akin to those discussed in the paper. Although the subject is of a highly scientific nature, it is presented in a manner that will engage the interest of the general reader as well as that of the scientist. An interesting side of this work not discussed by the lecturer is the amount of heat developed in this dance of the molecules, and the extent of the luminous effect compared with the electric energy expended.

The concluding paragraphs of Professor Crookes' admirable address, which, with this exception, appears in full in another part of the REVIEW, are as follows:

I frankly admit I have by no means exhausted the subject which daily and nightly fills my thoughts. I have ardently sought for facts on which to base my theory. I have struggled with problems which must be conquered before we can arrive at exact conclusions—conclusions which, so far as inorganic Nature is concerned, can only be reached by the harmonious interfusion—not confusion—of our present twin sciences, electricity and chemistry. Of this interfusion I have just endeavored to give you a foretaste. In elaborating the higher physics, the study of electrical phenomena must take a large, perhaps the largest, share. We have invaded regions once unknown, but a formidable amount of hard work remains to be completed. As we proceed we may look to electricity not only to aid, as it already does, our sense of hearing, but to sharpen and develop other powers of perception.

Science has emerged from its childish days. It has shed many delusions and impostures. It has discarded magic, alchemy, and astrology. And certain pseudo-applications of electricity, with which the present institution is little concerned, in their turn will pass into oblivion. There is no occasion to be disheartened at the apparent slow pace of elemental discovery. I hold the firm conviction that unflagging research will be rewarded by an insight into natural mysteries such as now can scarcely be conceived. There is no stopping half way, and we are resistlessly driven to ceaseless inquiry by the spirit "that impels all thinking things, all objects of all thought, and rolls through all things."

A MUNICIPAL LIGHTING FABLE.

Our interesting contemporary, *Whipple's Reports*, in its February issue prints this fable:

Once upon a time there dwelt for many years together a Wolf, a Fox and an Ass. One day there came a separation and the Wolf and the Fox married. At the end of the year the Ass concluded to follow the example of his former companions and called them in for advice.

"How much does it cost you to live?" asked the Ass.

"Fifty bushels of grain," quoth the Wolf.

"Ten bushels," said the Fox, "and I live as good as my brother, the Wolf, does."

"Be it so," said the Ass; "I'll follow your advice," and he straightway went out and selected his mate, while all the other asses denounced the Wolf as a spendthrift and a bad man.

MORAL: The Wolf had gone to housekeeping, and had paid for his own food and fuel. The Fox had lived with his father-in-law.

The time for subscribing to the 40,000 shares of Westinghouse preferred stock has been extended to February 15. There is every prospect of the full amount being taken by that time.

CORRESPONDENCE.

OUR BOSTON LETTER.

Mr. H. A. Cleverly, the well-known electrical manufacturer, of Philadelphia, is visiting this section, combining business with pleasure.

Mr. Louis R. Wallis, for several years connected with the office of the Bernstein Electric Manufacturing Company, has accepted the New England agency of the Buckeye Electric Company and will have an office at No. 85 Water street, this city.

Electric Cars will soon be running on the streets of Gloucester, Mass., the street railway company of that town having already commenced to equip its line with the single trolley system.

The **Connecticut Motor Company** is said to be considering the advisability of removing its factory from Plantsville to New Britain, Conn., where improved manufacturing and freight facilities may be had.

The **Electric Light Committee** of the N. E. Insurance Exchange, has appointed Mr. J. Couillard as electrical inspector. Secretary Goddard will, however, retain the general direction of the electrical inspection department of the Exchange.

Messrs. Kendall & Slade, the widely known construction firm of this city, have just finished the installation of an isolated electric plant at the City Hall, Dover, N. H. The lighting capacity of this plant is 750 (16 candle-power) incandescent lights. The same firm recently wired the First Baptist Church, of Malden, Mass., for 250 incandescent lights. Current will be furnished by the local electric light company.

A **New Electric Light Station** will be erected by the Concord, N. H., Gas and Electric Light Company. The new building will be 60x38 feet dimensions and fireproof. The equipment of the electric light department will be increased by a Reynolds-Corliss engine of 225 horse-power and two additional boilers.

A **New Corporation** has just been organized at Portland, Me., to be known as the Telecene Company. Capital stock, $15,000. This company will manufacture electrical instruments.

The **Bradbury and Stone Company,** of Lowell, Mass., is energetically pushing its new storage battery, and has already received several encouraging orders, among which is one for 200 batteries from a large electrical company in this city.

The **Germania Electric Company** has purchased the patents and good will of the Schaefer Electric Manufacturing Company, of Cambridgeport, Mass. At a meeting of the directors, recently, Mr. Leopold Schlegelmilch, of Boston, was elected president. The company's factory is at Marlboro, Mass.

The **Union Electric Manufacturing Company,** the recently organized electrical enterprise at Bridgeport, Conn., has already leased a factory on John street and equipped it with new machinery. The company will have several electrical specialties ready to offer to the trade before the middle of March.

Boston, Feb. 7, 1891. W. I. B.

OUR ST. LOUIS LETTER.

Several weeks ago the local papers came out with the startling announcement that a company had been organized to push the patents of a Mr. Wellington Adams, and to begin suit against the various trolley systems for infringement. The stockholders of the new company are Gov. David R. Francis, Dr. Isaac, Dr. Morgan, Web. M. Samuel, Hugh Rogers, Charles Thaw, Ewing Hill, G. W. Steedman, Seth W. Cobb, N. G. Larimore, F. C. Nipher, Charles Orthwein and Dr. Wellington Adams.

It is to be incorporated in the State of Illinois as the Adams Electric Railway Company, and with a capital of $5,000,000. It is to be incorporated in Illinois in place of Missouri, because the latter State requires that one-third of the capital be paid up while the former does not. The patents of this company were formerly in the hands of the Adams Electric Company, but have since been bought out by the new company. Judge Young and Given Campbell have been retained to press the suit against the electric companies. Judge Young has just returned from Washington, D. C., where he has been examining the records of the Patent Office. The Adams Company was bought out for $25,000, and all its stockholders admitted into the new company. This concern will place 20,000 shares of its stock as treasury stock to be sold at option, while the remaining 180,000 shares will be pooled so as not to allow the outside electric companies to get a controlling interest. The test case will be made in Boston and probably by the spring term. They have not decided on what company they will begin their suit for infringement. If the company has any good ground for their action they have a good thing, since their claims will affect the Thomson-Houston, Sprague, Short and Westinghouse systems.

A very important bill has been introduced into the legislature requiring the placing of all the wires underground. A vigorous protest has been made by the street railway, telegraph, telephone and electric light companies of this city, while the city itself is so much in favor of it that City Counsellor Bell has left for Jefferson City to argue in favor of its passage. The electric street railways have sent a complaint to the effect that they cannot operate under the law. The electric light companies claim that if it passes, the city, with which they have lighting contracts, will be obliged to pay half of the expenses of building the conduits. The telephone and telegraph companies say their service will be ruined if they use the same conduit as that in which high tension wires are run.

A bill has been introduced into the legislature regulating the charges of the telephone companies doing business in the State. It proposes to reduce the present rate of $100 per annum on business telephones to $50, and that on public telephones to $75. The bill provides a fine of not less than $200 nor more than $500 for its first violation; of not less than $500 nor more than $1,000 for the second violation, and of $2,000 for each succeeding offence.

The Carondelet Electric Light & Power Company are hard at work on the plans for their new plant. They have secured a piece of land 163x185 feet, and will at once begin the erection of the power house. They have not yet decided on what system to adopt. O. A. Haynes has been elected general manager.

A Novelty that the Southern Railway Company has placed on all its motor cars is Mr. Tom Johnson's patent guard. This guard is in the shape of a heavy board grating which extends out several feet in front and behind the motor car. It is as broad as the car, and is raised about a foot from the ground. Equipped in this way a motor car is well protected from running over any one, as the guard is low enough to catch up and carry any one into whom it runs, and extends sufficiently behind to prevent any one from falling between the motor and trail cars.

Last week the Broadway (St. Louis) cable road started up. Both of the power stations were equipped with the Thomson-Houston dynamos for incandescent lighting purposes.

The Southern Electrical Supply Company reports a very good business. Among recent orders for wire were several large ones from Abilene and Dallas, Texas, and Keokuk, Iowa. The order from Abilene is for the total equipment of the big plant just going up there, while Keokuk wants more than 20 miles of wire. They have received much of the street railway business here. They furnished all the feed wire for the Missouri R. R. The Southern Railway Company ordered 15 miles of wire, 9 of which being No. 30 stranded Candee feeder wire, and the remainder Okonite. Another equipment was on the extensions of the Union Depot line.

The Emerson Electric Company report a brisk demand for their new cut-out. The Bagnall live wire crossing is also taking well, they having just received orders from Salt Lake City, Troy, N. Y., Chicago, and from several southern points.

The Missouri Electric Light & Power Company have recently been enlarging their plant. They have just put in another 3,000 incandescent light Westinghouse dynamo, making in all nine dynamos and a 300 horse-power Westinghouse compound engine. They now have a capacity of 27,000 lights. They are running 35,000 incandescent lights in this city and are increasing at the rate of 2,000 a month.

A Company that was reorganized not long ago was the Electric Date and Time Stamp Company. It has been incorporated as the Stephenson-Hoggson Electric Company, with a capital of $100,000, all paid up. They still occupy their old quarters on Olive street, but expect soon to build a large plant convenient to the railroads. They are manufacturing a full line of supplies, besides several specialties. A specialty which they hope to have out prominently before the public is their electric date and time stamp. They intend to introduce it in England, Germany and France, and are at present negotiating with the government for its introduction into the post offices. Samuel H Hoggson is superintending the affairs of the company.

The Hazeltine Electric Company are busy with their patent arc light carbon shield. Several are in daily use on the lights of the Municipal Company, and they are being tested by several other concerns.

The Western Electrical Supply Company are, as usual, busy. They report a good big business, especially in wire.

The Fay Gas Fixture Company are fitting up the Boatmen's Bank with electrical fixtures. This is one of the best contracts of the season, calling for a very fine equipment in electroliers.

Mr. Irvine, who until very recently represented the National Electric Manufacturing Company, of Eau Claire, Wis., has been promoted to the position of superintendent at the works. Mr. Hopkins will take his place in St. Louis.

St. Louis, January 20th. W. H. B.

OUR ALBANY LETTER.

Assemblyman Endres introduced a bill, Friday morning, providing for the appointment in cities of 100,000, of a local transit service inspector by the mayor, at a salary of from $2,500 to $5,000. His duty shall be to enforce State laws governing local transportation companies. He shall see that a sufficient number of coaches are furnished, that cars are properly heated and ventilated, and shall examine the books of companies which pay any portion of their receipts into the city treasury.

The tangle in the Telephone wires caused by the recent severe snow storm is just being straightened out in Kingston. Communication was badly crippled.

The new Saugerties Electric Light Company began to furnish lights to its patrons Thursday.

The Albany Railway Company has just made a successful experiment in killing a horse at its stables by electricity. The animal was one of the old street car-horses and its leg had been broken. The entire current was put through the horse after the cars stopped at night. It was dead in 23 seconds.

The application of the Troy and Albia Horse Railroad Company for an increase of capital stock from $50,000 to $400,000, for the purpose of equipping its lines with electricity, and that of the Glens Fall, Sandy Hill and Fort Edward Railroad Company for a change of motive power from horses to electricity, have been approved by the board of railroad commissioners.

The American Rapid Telegraph Company, appellant, against Jacob Hess and others, respondent, have entered an appeal in the Court of Appeals, here, from the judgment of the general term, first department, affirming a judgment in favor of defendant. The chief object of this action is to obtain an injunction to restrain the Mayor of New York, the Commissioner of the Department of Public Works and the members of the Board of Electrical Control, their agents and servants, from cutting down the plaintiff's telegraph poles and putting their wires in the subways prepared for them, under the provisions of chapter 716 of the laws of 1889. But for the purpose of maintaining the action the plaintiff has alleged its right to resist these acts, especially that of 1887, as in conflict with certain restraints enacted by the Constituton of this State and by the Constitution of the United States.

The Electric Street Railway to Charlotte from Rochester is one of the most popular means of transit to the lake. Considering its short existence its success is phenomenal. During 1890, 470,000 passengers were carried. The electric cars on that road from January 1, 1890, to January 1, 1891, traveled 197,342 miles, or more than seven times the distance around the globe. A car of the Rochester street railway travels on an average 125 miles a day.

At the St. John's Church Fair, recently held at Schenectady, the Edison Company had a marvelous electrical exhibit. The display was part of that used at the Paris Exposition. Since that time it was packed away at Orange, N. J., until brought to Schenectady especially for the fair. Upon the brilliantly illumined platform was seen every practical appliance of the wonderful electrical force. All devices were exhibited in miniature. A life-sized bust of Edison was the central ornament of the exhibit. There was everything, from the dynamo and electric lamp to the talking doll. The display excited wide comment from visitors at the fair. L. M. W.

Albany, February 7, 1891.

New York Electric Club.

The new class of members—associates—will undoubtedly prove a good thing for the club. As soon as the new rule goes into effect it is understood that over 25 young men from the Edison General Electric Company alone will join.

Recent Out-of-Town Visitors.—Morris L. Johnston, Chicago; Henry B. Cram, Boston; Alex. Rogers, Washington, D. C.; S. C. Bowen, Idaho; Chas. E. Miller and Morris W. Mead, Pittsburgh; Walter S. Coles, Cincinnati; J. C. Kay, Pittsburgh; Wm. C. Miller, Albany, N. Y.; W. C. Sayles, Jr., Pawtucket, R. I.

Mr. Henry Hine the well-known electrical engineer, as well as accomplished gentleman, of this city, has accepted the position of general manager of the Stanley Electric Manufacturing Company, of Pittsfield, Mass., of which Mr. W. Stanley, Jr., the well-known inventor, is electrician. Mr. Hine has been for years identified with the electrical field, first very actively with the United States Electric Lighting Company, and more recently as district agent of the Westinghouse Electric Company, and is one of the ablest men in the field. The Stanley Company is to be congratulated.

The Storage Battery Line in Washington.

The storage battery cars which are to form the equipment of the extension of the Eckington Railroad, Washington, D. C., are being manufactured at the works of the Brill Company and will be fitted with the electrical apparatus by the Accumulator Company, in Philadelphia, without delay. Each car will be provided with two 15 horse-power motors, geared to the axles of the car-wheels, arranged to run in oil, secured in dust-tight coverings and fitted with all necessary appliances of the most approved kind. Two sets of batteries of 136 cells each will be provided for each car and they are to be fully charged at the end of every trip of not exceeding 20 miles or, if out of use, at the end of every period of seven days. Each car will be lighted by eight 10 candle-power lamps. It is guaranteed that the cars can run along G street at the rate of 15 miles per hour when carrying 50 passengers, or an equivalent weight of 6,000 pounds and that, with this load, they can ascend grades not exceeding five per cent. and not longer than 660 feet at the rate of five miles an hour, and grades not exceeding three per cent. and not longer than 600 feet, at the rate of six miles an hour. Two horse-power hours of energy delivered to the battery at the charging station will suffice to run a car one mile on a straight level track when loaded as above, and one set of batteries, when fully charged, will be capable of running a car 50 miles in the regular service on the road. The charging station is about one and a half miles from the portion of the road where the storage battery cars are to be used. When a car is ready for service it will leave the charging station, run down to its section of the line, make the requisite number of trips and then return to the power house and change batteries. The Accumulator Company is to have supervision over the operation of the electrical equipment, and is to keep the equipment in good order for a period of three years for a stated charge per car mile, unless the railroad company should decide to operate the road itself. It is estimated that the cost of maintaining and operating this plant, not including the wages of conductors and drivers, will be between 12 and 14 cents per car mile.

Vanderbilts Invest in Edison Stock.

The advance in Edison general stock of 7½ per cent. at the opening yesterday, was accompanied by a report that Henry Villard has sold all of his stock to the Vanderbilts. This was denied by Mr. Villard, who stated that he still is the largest individual stockholder. From authoritative sources it is learned, however, that the Vanderbilts have within two days bought a very large amount of Edison general stock, and will be represented in the directory by H. McK. Twombly. Mr. Spencer Trask, who has been identified with the property for many years said: "The public is beginning to realize the value of Edison stock. I feel that the stock has passed beyond the speculative era, and is now fairly entitled to be considered as a sure investment stock."—*Daily Financial News, Feb.* 6, 1891.

FINANCIAL.

Closing quotations of electric stocks, from F. Z. Maguire & Co., Electrical Securities, 18 Wall street, N. Y., Saturday, February 7, 1891. New York, Boston and Washington Stock Exchanges. Pittsburgh closing February 6.

NEW YORK.	
Western Union Telegraph Co.	81¾
American Telegraph & Cable.	83
Central and South American.	145
Mexican	210
Commercial Cable Co.	104
Postal Telegraph Cable.	39
Edison General Electric Co.	101½
Consolidated Electric Light.	
Edison Electric Illuminating Co.	79
United States Electric Light.	30
North American Phonograph.	15
BOSTON.	
Thomson-Houston Electric Co.	*46¼
" " " Preferred	25½
" " " Series C.	13¾
" " " Series D.	7½
" " International Co.	
" Welding Co.	
" European Welding Co.	60
Ft. Wayne Electric Co	139½
TELEPHONE:	
American Bell	194
" Rights	18
Erie	*47½
New England	*50
Mexican	.65
Tropical American	
MISCELLANEOUS:	
Edison Phonograph Doll	1
WASHINGTON.	
Pennsylvania Telephone	25
Chesapeake and Potomac	63
American Graphophone	8¼
United States Electric Light (Wash'ton)	138
Eckington and Soldiers' Home Electric Railway	56¼
Georgetown and Tennallytown	51
PITTSBURGH.	
Westinghouse Electric Mfg. Co.	16¼

* Ex. Div.

Telephonic News

*** A telephone line is to be established between Norfolk and Newport News which will cross Hampton Roads.

*** The Wisconsin Telephone Company will be required to furnish free telephones for the use of the city of Superior.

*** A war of extermination on the "whisperphones" has been begun by the Metropolitan Telephone and Telegraph Company.

*** At a meeting of the directors of the New England Telephone and Telegraph Company, held last week, a dividend of $1.25 per share was declared, payable on Saturday, February 14, 1891, to stockholders of record at the close of business on Saturday, January 31, 1891. The transfer book will be closed from February 1 to February 14, 1891, both days included.

Copper Gossip.

It is stated on good authority, says the *Journal of Finance*, that the amount of lake copper held by the bankers is only 8,400,000 pounds, distributed in five or six warehouses in New York. Rumor has it that a prominent firm in Boston offered to take this copper at 14 cents a pound, if the Calumet and Hecla people would agree not to sell under 15 cents. The latter, however, are averse to making such an agreement unless the purchasers would make a similar one.

The Professor, the Key and the Armature—A Study in Light and Shade.

Prof. Thomas, of the Ricker Classical Institute, took 50 of his pupils to the electric light station in Houlton, Thursday evening, to give them some practical instruction in the science of electric lighting. The professor took his place close to the armature, and to better explain its workings to the class about him he held a common door-key in his hand. At a certain stage of the exercises the key came in contact with the armature, the magnetic power was too great to break the connection and in a few moments the insulation was torn off and the electric generator burned out. As a result of the experiment Houlton will be in darkness until a new armature arrives from Connecticut.—*Biddeford, Me., Journal.*

It has been remarked before now that few college professors could run a peanut-stand successfully.

Leading-In Wires for Incandescent Lamps.

In a late issue of the REVIEW was described a plan proposed by Mr. Edison for economizing the amount of platinum used as leading-in wires for incandescent lamps. Edison's plan was to form the leading-in wire of a small section, say an eighth of an inch of platinum with extensions of some other metal, as copper; the platinum forming a perfect seal with the glass and the other metal acting as the support for the filament. Another plan for accomplishing the same end is proposed by Turner D. Bottome, of Hoosick, N.Y. An alloy of nickel or cobalt, platinum and silver, in the proportion of 84 parts of nickel or cobalt, 15 parts of platinum, and one part of silver, all by weight, is made by melting the metals together, granulating them and remelting a few times in order to produce a thoroughly homogeneous compound. The material is then made into wire of the required size. It is claimed that such wire has all the advantages of platinum for sealing-in purposes, and yet contains only a small percentage of this expensive metal.

Sir John Macdonald has been requested to send a delegate to a convention to be held in Sydney, N. S. W., in April, for taking some definite step toward the laying of the Pacific cable from Australia to British Columbia.

ELECTRICITY IN TRANSITU—FROM PLENUM TO VACUUM.

FROM AN ADDRESS OF PROFESSOR WILLIAM CROOKES, F. R. S., BEFORE THE INSTITUTION OF ELECTRICAL ENGINEERS, LONDON.

INTRODUCTION.

Numberless instances show that pure research is the abundant source from which spring endless streams of practical applications. We all know how speculative inquiry into the influence of electricity on the nervous systems of animals led to knowledge of current electricity, and ultimately to the priceless possession of the telegraph and the telephone. The abstract study of certain microscopic forms of parasitic vegetable life has enabled us to give to fermented solutions of sugar the exact flavor and aroma of the most highly-prized wines, and probably, ere long, will put us in a position to increase at will the fertility of the soil. In a different direction the same class of abstract researches applied to medical science has brought us within measurable distance of the final conquest over a large class of diseases hitherto incurable; and without egotism I may, perhaps, be allowed to say that my own researches into high vacua to some extent have contributed to the present degree of perfection of the incandescent lamp. Surely, therefore, whilst eagerly reaping and storing the harvest of practical benefits, we must not neglect to scatter more seed for future results, perchance not less wonderful and valuable.

In submitting to you certain researches in which electricity is used as a tool, or as a means of bringing within scope of our senses phenomena that otherwise would be unrevealed, I must for a moment recall to your minds the now generally accepted theory of the constitution of matter.

KINETIC THEORY OF GASES.

The kinetic theory of gases teaches that the constituent molecules dart in every possible direction with great but continually varying velocities, coming almost ceaselessly in mutual collision with each other. The distance each molecule traverses without hitting another molecule is known as its *free path;* the average distance traversed without collision by the whole number of molecules of a gas at any given pressure and temperature is called the *mean free path.* The molecules exert pressure in all directions, and are only restrained by gravitation from dissipating themselves into space. In ordinary gases, the length of the mean free path of the molecules is exceedingly small compared with the dimensions of the vessel, and the properties we then observe are such as constitute the ordinary gaseous state of matter, which depend upon constant collisions. But if we greatly reduce the number of molecules in a given extent of space the free path of the molecules under electric impulse is so long that the number of their mutual collisions in any given time in comparison with the number of times they fail to collide may be disregarded. Hence, the average molecule can carry out its own motions without interference. When the mean free path becomes comparable to the dimensions of the containing vessel, the attributes which constitute gasity shrink to a minimum, the matter attains the ultra-gaseous or "radiant" state, and we arrive at a condition where molecular motions under electrical impulse can easily be studied.

The mean free path of the molecules of a gas increases so rapidly with progressive exhaustion, that whilst that of the molecules of air at the ordinary pressure is only $\frac{1}{10000}$th of a millimetre, at an exhaustion of a hundred-millionth of an atmosphere—a point (which, with present appliances, it is easy to attain) corresponding to the rarefaction of the air 90 miles above the earth's surface—the mean free path will be about 30 feet; whilst at 200 miles above the earth it will be 10,000,000 miles, and millions of miles out in the depths of space it will become practically infinite.

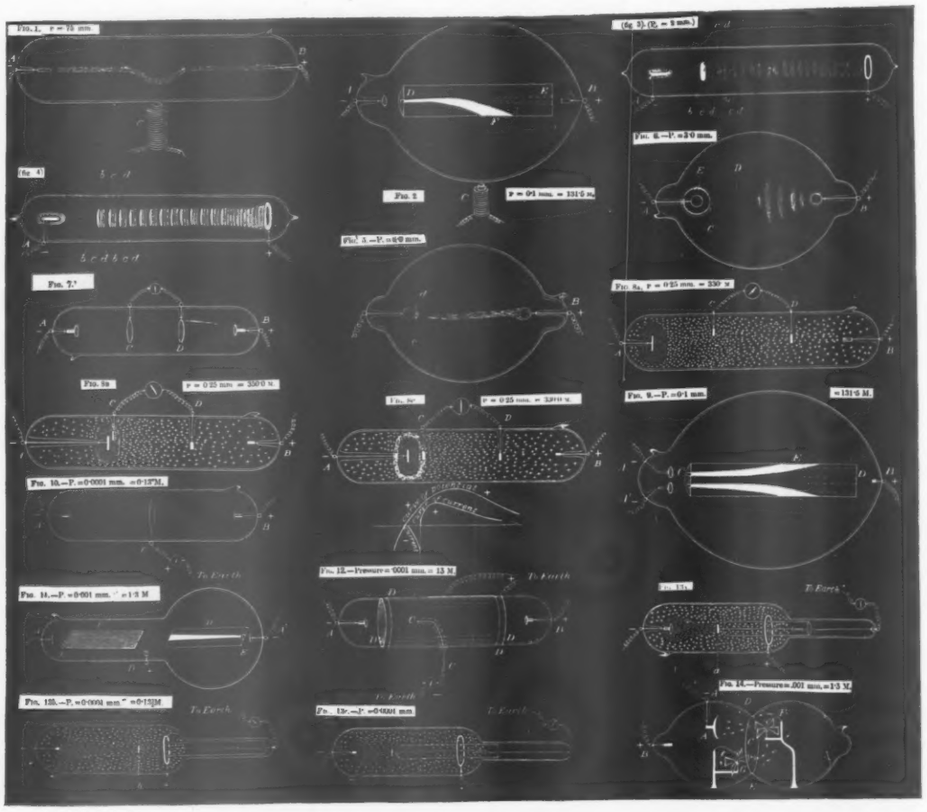
In discussing the motions of molecules we have to distinguish the *free* path from the *mean free path.* Nothing is yet known of the *absolute* length of the free path nor of the *absolute* velocity of a molecule. For anything we can prove to the contrary, these values may vary almost from zero to infinity. We can deal only with the *mean* free path and the *mean* velocity.

THE PASSAGE OF ELECTRICITY THROUGH RAREFIED GAS.

As most of the experiments I put before you to-night are connected with high vacua, it is not out of place to refer to the pump by means of which these tubes are exhausted. Much has been said lately in recommendation of the Geissler pump and its many improvements, but I am still strongly in favor of the Sprengel, as with it I have obtained greater exhaustion than with any other. I should like to point out that the action does not stop when we cease to see air specks passing down the tubes, but continues long after this point has been passed.

The various phenomena presented when an induction spark is made to pass through a gas at different degrees of exhaustion point to a modified condition of the matter at the highest exhaustions. Here are three exactly similar bulbs, the electrodes being aluminium balls, and the internal pressures being respectively 75 mm., 2 mm., and 0.1 mm. If I pass the induction current in succession through the bulbs, you will perceive in each case very different luminous phenomena. Here is a slightly exhausted tube, Fig. 1, like the first in the series just exhibited (75 mm.), the induction spark passes from one end to the other A, B, and the luminous discharge is seen as a line of light, acting as a flexible conductor. Under the tube I have an electro-magnet, C, and on making contact the line of light dips in the center down to the poles of the magnet, and then rising again proceeds in a straight line. On reversing the current the line of light curves upwards. Notice that the action of the magnet in this case is only local.

In a highly exhausted tube the action is quite otherwise. Such a tube is before you (Fig. 2), and in it I have carried the exhaustion to a high point (0.1 mm.). I pass the induction current, and you perceive the electrified molecules, like the line of light in the first tube, also move in straight lines, and make their path apparent by impinging on a phosphorescent screen, D, E. If, however, I submit them to the action of a magnet, C, their behavior is different. The line dips down to F, but does *not* recover itself. It seems that in the tube first shown we have to do with the average behavior of the molecules of gas in its totality. In the second case, where the gas has been greatly attenuated, we are merely concerned with the behavior of the individual molecules of which it was originally composed.



CROOKES' RESEARCHES IN RADIANT MATTER.—PLATE I.

THE STRATIFIED DISCHARGE.

When the gas is rarer than is necessary to give the flexible line of light, as shown in the first experiment, the luminosity is plainly discontinuous, or, as it is termed, stratified.

A very good illustration of this fact may be taken from the moving crowd in any much frequented street—say Fleet street. If at some time when the stream of traffic runs almost equally in both directions, we take our stand at a window from which we can overlook the passing crowd, we shall notice that the throng on the footway is not uniformly distributed, but is made up of knots—we might almost say blocks—interrupted by spaces which are comparatively open. We may easily conceive in what manner these knots or groups are formed. Some few persons walking rather more slowly than the average rate, slightly retard the movements of others, whether traveling in the same or in an opposite direction. Thus a temporary obstruction is created. The passengers behind catch up to the block and increase it, and those in front, passing on unchecked at their former rate, leave a comparatively vacant space. If a crowd is moving all in the same direction, the formation of these groups becomes more distinct. With vehicles in crowded streets the result, as everyone may have remarked, will be the same.

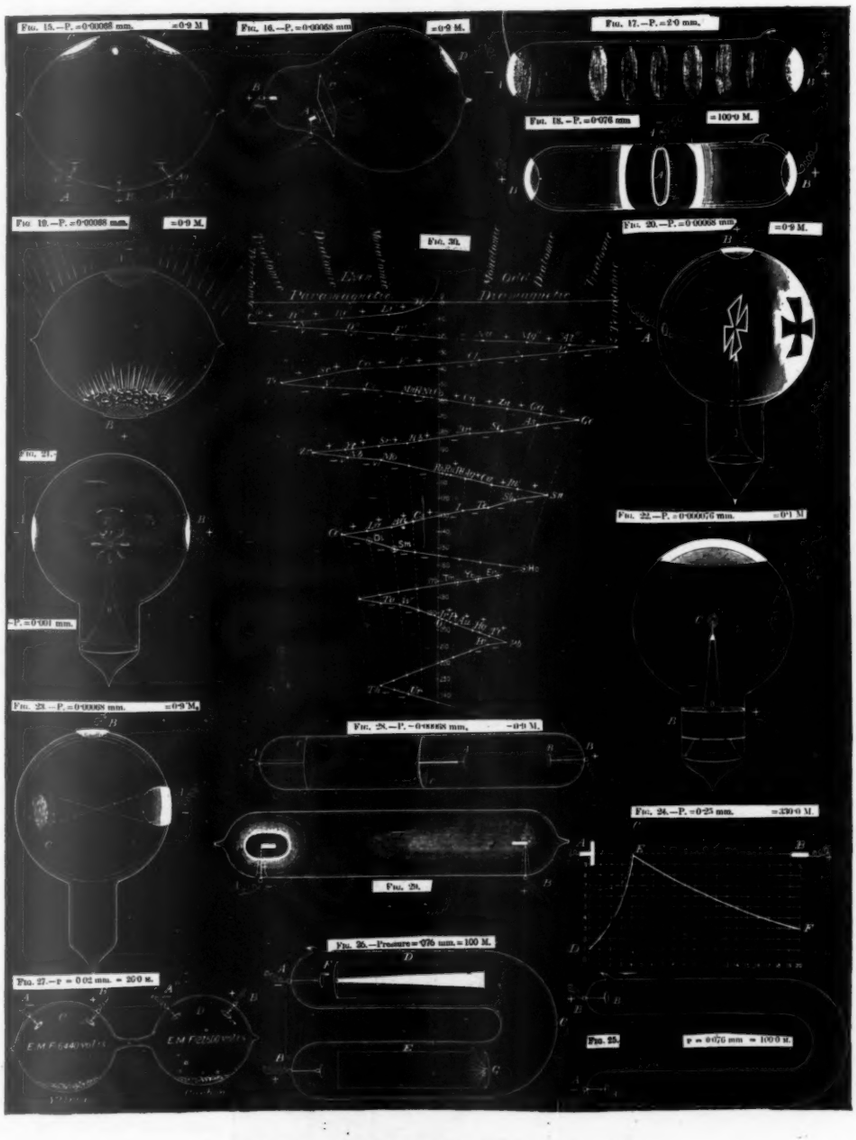
If we pass to yet more minute substances, we observe the behavior of the molecules

of a rarefied gas, when submitted to an induction current. The molecules here are free, of course, from any caprice, and simply follow the law I seek to illustrate, and though originally in a state of rampant disorder, yet under the influence of the electric rhythm, they arrange themselves into well defined groups or stratifications; the luminosities show where arrested motion with concomitant friction occurs, and the dark intervals indicate where the molecules travel with comparatively few collisions.

PARTI-COLORED STRATIFICATIONS.

As another illustration of stratifications in a moderately exhausted tube (P. =2 mm.), I will take the case of hydrogen prepared from zinc and sulphuric acid, after being passed through various purifying agents, dried in the usual manner, and exhausted with a mercury pump, Fig. 3. I pass the induction current, and we see that the stratifications are tri-colored, blue, pink and grey. Next this tube (Fig. 5, P. =6 mm.), where you will observe that the positive glow, extending as a pink streak from the positive electrode, B, ends about 10 millimetres before the spot of blue light, C, representing the negative glow. This gap, or non-luminous hiatus, D, is Faraday's "dark space," separating the negative glow from its electrode in another space. In this tube it is so small that the glow appears to be in actual contact with the electrode, but on exhausting a little further it rapidly separates; and in the next tube (Fig. 6.), containing air at a little less pressure (P. = 3 mm.), this dark space, E, has extended so as to remove the negative glow about four millimetres from the electrode, A. It is with this second dark space that I particularly wish to deal to-night. Therefore, I shall refer to it as the "dark space," meaning always that in the negative glow.

In the experiment just shown with dydrogen stratifications, the contents of the tube under the electric discharge still obey



CROOKES' RESEARCHES IN RADIANT MATTER.—PLATE II.

the negative pole, A, is a luminous layer, then comes a dark interval or Faraday's dark space (see below), and after this are the stratifications, the front component (*b*) of each group blue, the next (*c*) pink, and the third (*d*) grey. The blue disks are somewhat erratic. At a certain stage of exhaustion all the blue components of the stratifications suddenly migrate to the front, forming one bright blue disk, and leaving the pink and grey components by themselves. The tube before you, Fig. 4, is at this particular stage of exhaustion, and on passing the current you observe the blue disk only (*b*) is in front. When the tube contains a compound gaseous residue of this kind, the form of stratifications can be very considerably altered by varying the potential of the discharge.

THE DARK SPACE.

After the stratification stage is passed we come to a very curious phenomenon, the so-called "dark space." It is seen in tubes containing gas only slightly rarefied, as in the laws following from the average properties of an immense number of molecules moving in every direction with velocities of all conceivable magnitudes. But if I continue exhausting, the dark space, E, round the negative pole, A, becomes visible, grows larger and larger, and at last fills up the entire tube. The molecules at this stage are in a condition different from those in a less highly exhausted tube. At low exhaustions they behave as gas in the ordinary sense of the term, but at these high exhaustions, under electric stress, they have become exalted to an *ultra-gaseous* state, in which very decided properties, hitherto masked, come into play.

The radius of the dark space varies with the degree of exhaustion, with the kind of gas in which it has been produced, with the temperature of the negative pole, and to a less extent with the intensity of the spark.

EXPLORATION WITH IDLE POLES.

Wishing to learn something of the electrical condition of the matter within and without the dark space, I made a tube, Fig. 7, having besides the positive and negative terminals, A B, two extra intermediate poles, C and D; the tube showed that when the exhaustion was such that both the idle poles were outside the dark space, on passing the current through the tube, there was a considerable difference of potential between them when measured on the galvanometer. If the exhaustion was carried so high that one of the extra poles was just on the border of the dark space, then no current passed between them. When the exhaustion was still further increased so as to enclose one of the extra poles fully in the dark space, again there was a great difference of potential between them, but the direction was reversed, the pole at the highest potential now being the one formerly at lowest potential.

When a dark space has been further explored by means of a movable negative pole, I found that the effects did not depend essentially on the exhaustion, and were really due to the position occupied by the extra poles with regard to the dark space.

I have here a working model of an apparatus which will make these puzzling indications clear to all.

A cylindrical tube (Fig. 8, *a*, *b* and *c*, P—0.25 mm.), furnished with the usual poles, A B, at the ends, has two extra or idle poles near together at C and D. The pole A is movable along the axis of the tube, so that when exhausted the dark space can be brought to any desired position with respect to the idle poles C and D. The shading and + and — marks roughly show the distribution of positive and negative electricity inside the tube. I start with the negative pole, A, as far as possible from either idle pole, Fig. 8, *a*. Turning on the coil you see the dark space surrounding the pole A, and the idle poles quite outside.

The shading shows that each idle pole is in the positive area, and on testing with a

(*Continued on page 304.*)

TELEGRAPHIC

.... The underground system of telegraphs of the German empire has a total length of 3,600 miles.

.... In view of the reduced cable rates to Australia, the Eastern Telegraph Company have recently laid a new cable from Suez to Aden. A second new cable will be completed in a few weeks for the section between Aden and Bombay. An additional cable, to be laid between Madras and Penang, is already completed.

.... Mayor Matthews, of Boston, has sent to the Board of Alderman a message containing grave charges against Commissioner William M. Osborne, of the Board of Police of the city of Boston, and a suggestion that the legislature be petitioned to investigate the same. This action on the part of the Mayor has opened a bitter controversy that will result in the political death of one or the other. Mayor Matthews makes the charge that Commissioner Osborne used his official influence to secure a location for 318 telegraph poles for the New England Printing Telegraph Company, in which he and his cousin, Congressman McKinley, of Ohio, and the latter's brother, are pecuniarily interested. The Mayor also intimates other charges which he says call for legislative investigation.

Kalakaua's Voice Will Live.

[From the San Francisco *Chronicle.*]

Outside the little circle of immediate friends and attendants upon the late King Kalakaua who were admitted into the sick chamber, it is not known that for the 10 days prior to the monarch's death an Edison phonograph stood near the bedside. Many who saw the instrument daily never suspected its character or use, and during the excitable days preceding the King's death, during which every nerve was taxed to its greatest tension, the innocent-looking little machine reposed in its shaded corner unnoticed and unobserved by all except by the King's chamberlain and his secretary.

When the phonograph was brought into the sick-room, last Monday a week ago, Chamberlain Macfarlane explained its use and purpose to the King, and begged that he would speak into the receiver. The near approach of death was not suspected at that time, but it was urged upon Kalakaua that in after years his people would be rejoiced to listen to the natural tones of their former ruler. Little did either the King or the chamberlain suspect that in less than a week the little waxen scroll containing the words of King Kalakaua in audible characters would be so highly prized.

The King consented, and, raising himself up in bed, put the receivers in his mouth and talked into the instrument in his native tongue. He spoke slowly and with some effort for nearly 10 minutes, then sank back exhausted, promising to complete the message when he should feel stronger. The next day came, with the excitement incident to prepairing for the supper in honor of the King at the California Hotel, and the phonograph was forgotten. On the following day came the entertainments for the Mystic Shrine, and again the phonograph was neglected.

After that until death had closed his lips forever both Secretary Baker and Chamberlain Macfarlane watched and waited anxiously for the signs of returning consciousness, when they might have the King conclude the scroll, but the watching and waiting were fruitless.

On Wednesday the phonograph operator was sent for. He removed the waxen roll and gave it to Colonel Baker, who has since guarded it as sacredly as his own life. Yesterday he took it back to Honolulu with him, where its worth will be computed beyond measure in vulgar coin. It has not been read yet, nor will it be read until it is placed in an instrument upon Hawaiian soil. It will probably play a most important part in the Hawaiian obsequies.

* * The electric road between Ypsilanti and Ann Arbor, Mich., has been euphoniously christened the "Ypsi-Ann."

* * A movement is on foot for the construction of an electric railway from Derry Depot to Chester, N. H. The estimated cost for road and equipment is $60,000.

* * The New York State Board of Railroad Commissioners will hold a session at the chamber of commerce this week to hear the protests of the residents of the annexed district against the trolley system.

* * Winsted, Conn., will soon have electric cars on its streets. The street railway company of the town named has petitioned the Connecticut legislature for a franchise to use electricity as a motive power.

* * The application of the Troy and Albia Horse Railroad Company for permission to increase its capital stock from $50,000 to $400,000 has been approved by the New York State Railroad Commission.

* * The time for receiving tenders for the purchase or lease of the street railway tracks, together with the exclusive right of operating on the streets of the city of Toronto, Canada, has been extended from February 2 to February 20, 1891.

* * A preliminary organization has been effected of a corporation to construct an electric street railway line from Worcester to Millbury, Mass. The capital is to be $150,000, more than $80,000 of which is said to be already subscribed.

* * There are prospects of an electric railway all the way from North Easton, Holbrook and Brockton to Boston. The times are coming when the steam railroad companies will have to fight for the local and suburban passenger traffic.—*Boston Globe.*

* * A pin was lost from the trolley on an Augusta, Ga., electric car some time ago, and the car stopped. A hairpin furnished by a lady passenger enabled one of the cars to continue its trip to the Hill. The next morning the hairpin was removed and replaced by one made for the purpose.

* * The Michigan Central Railroad Company cut the wires of the Saginaw Electric Railroad Company because it interfered with the steam railroad, at least the Michigan Central people claimed it did. The electric railroad managers sued the steam railroad directors for $20,000 damages, and have recovered a vervict of $923.03 and costs.

* * The passing of an ordinance granting the St. Louis and Suburban Railway Company permission to change their motor power from cable and steam to electricity has awakened a new interest in the choice residence sites along the road. Already there have been several significant sales at prices slightly in advance of what the property sold for last Fall.—*St. Louis Republic.*

* * The Comptroller, Theodore W. Myers, says that he was misquoted by the daily papers as saying that the action of the New York Board of Electrical Control in granting the Fordham and Harlem Railroad permission to adopt the overhead electric system was outrageous. Mr. Myers asserts that what he did say was that the overhead electric system was an outrageous one for cities.

* * A. B. Johnson, of Lynn, Mass., has brought suit against the Edison General Electric Company for $30,000 damages. October 11 last, he was in the employ of the company at Salem, and while at work on the platform of a "tower" wagon, so called, fell and sustained such injuries, principally to the spine, that he has since been unable to use his lower limbs, and never again can walk.

A New Thomson-Houston Motor for Electric Railway Work.

The fact has been quite apparent for some time past to workers in the field of electrical street car propulsion that a slow speed electric motor, connected to the car axle by one gear and pinion, is a very desirable thing, and in many respects superior to the one with two sets of gears and pinions, which is in general use at the present time.

About a year ago the Thomson-Houston Electric Company began investigation and experiment upon single reduction, slow speed motors for electric railway purposes, and this work has resulted in the production of the motor shown in the accompanying illustrations. During the past year the first motor of this new type has been in service on an experimental car at the works of the Thomson-Houston Electric Company, at Lynn. During this time it has been the subject of the severest tests, in order that its weak points, if there were any, might be fully brought out and remedied. Two motors have also been in daily operation for some time on car 120 of the West End Street Railway, of Boston, where they have fully met the severe requirements of heavy traffic. They have been found to be more powerful in driving the car with the same amount of current than the high speed double reduction motors, and to be practically noiseless.

An examination of the illustrations will show that the motor is practically iron-clad, having two internal pole pieces of ample spread, carrying two field spools which practically surround the armature core, on the same principle as the well known arc dynamo designed by Prof. Thomson. The magnetic circuit is completed on the front end of the motor by the nose plate, and on the back by the frame, on which are cast the iron boxes and arms which serve as a support for the armature shaft and bearings.

The armature is of the Gramme ring type, which possesses many points of advantage over the drum type of armature. Any coil on a ring armature can be easily rewound without disturbing its fellows, while with the drum the winding must be removed down to the injured coil and rewound new from that point.

On the new type motor the brushes are placed in a horizontal fixed position, exactly opposite each other, and are easy of access for adjustment or examination. There is no sparking under any of the conditions of operating. A glance at the cuts will show that the field spools are protected at the front and back as well as on the top and bottom by the fields and frame, and, consequently, injury is almost out of the question; yet, as additional safeguard to these and the armature and commutator, a sheet-iron pan is employed, which closes in entirely the bottom and sides of the motor and extends above the center of the armature shaft. Its method of attachment is such that it can be readily removed, permitting easy access to the various parts of the motor for necessary repairs and adjustment. The pan, or case, as it may be called, can be extended as high as practice may prove to be desirable, and forms a most effective means of fully protecting the apparatus from snow, dirt and water. The desirability of such a device will be readily appreciated by those who have had coils burned out during the recent heavy snow and rain storms.

The mechanical details are as follows:

The spur pinion on the armature shaft is of steel, four and one-half inch face, and has 14 teeth, number three pitch.

The split gear on the car axle is of cast-iron with the same face, and has 67 teeth of the same pitch.

The speed of the amature shaft, relative to that of the car axle is, therefore, nearly 4.8 to 1. The motor is designed to clear the top of the rails four inches when mounted on 30 inch wheels. The speed of the armature when the car is running at 10 miles an hour will be 538 revolutions a minute; or the speed of the armature is 53 8 turns per minute per car mile per hour.

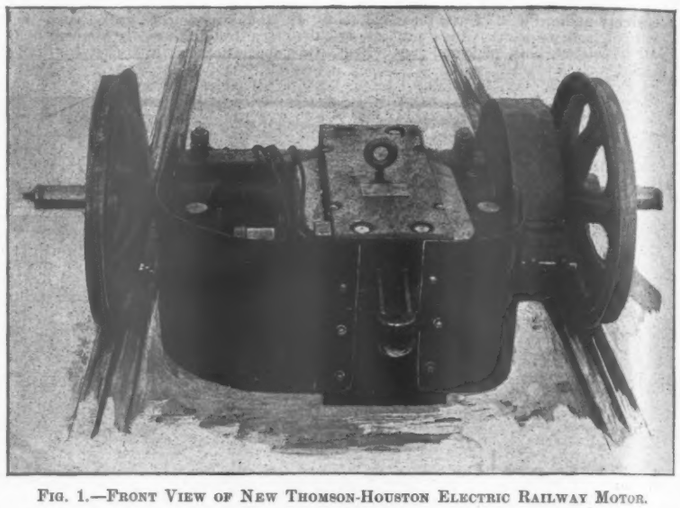


FIG. 1.—FRONT VIEW OF NEW THOMSON-HOUSTON ELECTRIC RAILWAY MOTOR.

The gears are entirely inclosed in a dust and oil tight case, which is provided with a hand-hole closed by a spring cover, permitting ready examination of gears and introduction of grease and oil to the interior of the case.

The advantage of a single reduction motor having its gears and pinions run in oil and fully protected, over double reduction motors, with two pairs of gears and pinions unprotected from dust and dirt, is quite apparent. In this new type motor the first cost and subsequent maintenance of the armature pinion and intermediate gear is entirely climinated. The single reduction gear corresponds to the old intermediate pinion and axle-gear wheel, but it has the great advantage of being boxed and run in oil, so that the important item of gears will be hereafter practically stricken out of the repair bill. The cost of repairing armatures will be substantially reduced by the new arrangement, but to what extent cannot yet be definitely stated.

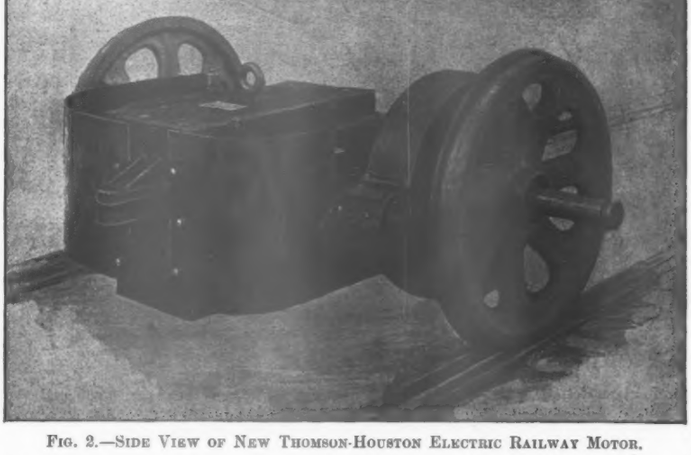


FIG. 2.—SIDE VIEW OF NEW THOMSON-HOUSTON ELECTRIC RAILWAY MOTOR.

Aside from the facility of removing and replacing the armature, and the ease with which one or more sections of a Gramme ring can be removed, the slow speed will materially lessen the bursting of binding wires, the displacement of coils and breaking of commutator connections, together with other injuries occasioned by centrifugal action.

Considerable noise has heretofore been caused by the brushes bearing on the high speed commutator. This noise, as well as that of the gears, has been entirely eliminated by the new form of machine so that the rolling of the wheels on the rails is the only sound to be heard in a car equipped with this motor even at its highest speed.

Another consideration of great value is the form of the magnetic field. In previous Thomson-Houston types of railway motors the magnetic field is short circuited outside of the armature, more or less, by the support necessary at the nose plate, and some sacrifice of the strength of this nose plate is required in some styles of eight-wheeled trucks. The effect of this short circuiting on the magnetic field is to weaken the power of the armature. The difficulty is entirely avoided in the new motor, which has substantially an iron-clad magnetic field.

The features of the new type motor may be briefly summed up as follows: Single reduction gear, run in oil and entirely protected from dust and dirt. Noise of gears and commutator avoided. Electrical and mechanical simplicity by the use of the two-pole motor, and slow speed and powerful torque by means of perfect proportions. Armature and fields protected from dust and water, thereby greatly reducing the tendency to "burn out" due to the latter cause. All parts of the motor accessible, so that repairs and adjustments are easy. The ring armature, which, if injured, can easily be repaired. Moderate weight, high commercial efficiency and small expense of maintenance.

Electric Lighting in Philadelphia.

No insurance loss occurred in any building in our city during the past year from fire where the cause could be in any way attributed to electric wires.—*Philadelphia Underwriters' Association.*

TO THE EDITOR OF ELECTRICAL REVIEW:

I herewith enclose you a report from the Philadelphia Fire Underwriters' Association. The clause marked (see above) is worthy special mention in your valuable paper. Although the clause is a small one it comprehends a great deal. With the large number of electric lights in the city of Philadelphia, it is something wonderful to have no fires whatever from electric light wires. We may be slow and accredited of being slow, and if it is a fact that we are slow in other things we are certainly slow in getting up electric light fires.

I am of the opinion that the credit is due to the close inspection and laying out of the electric light wires by the chief inspector, Wm. McDevitt, who has been and is a careful, earnest and observant student of fires, and especially fire risks as they have presented themselves during the past ten years. Not only does he and his assistants make a thorough inspection of all electric light wiring, both arc and incandescent, in this city, but he does more than this; he makes a thorough examination of the premises, condition of the building, character of business, peculiarities and surrounding influences, prior to the introduction of the electric light wires. While he has a general set of rules for simple guidance, he claims that conditions vary with each building in which electric lighting is introduced, and from this standpoint it may be stated, and from his thorough comprehension of the electric light problem (as to fire risks), is the credit due that we have had not one "electric fire."

I think your paper is the proper medium to ventilate this, and congratulate Mr. McDevitt on his singular success, as we know of no other large city that has escaped electric light fires in the year of 1890.

Yours very truly, C. A. BRAGG.

Philadelphia, January 29th, 1891.

BOOK REVIEWS.

"Lectures on the Electro-Magnet," by Sylvanus P. Thompson, published by the W. J. Johnston Company, Limited, New York.

This interesting little volume contains a series of four of the "Cantor Lectures" by Professor Thompson. Abstracts of these lectures have from time to time been published in the REVIEW. They are full of interesting matter. Professor Thompson has a well-deserved reputation for doing any work he undertakes thoroughly. In these lectures he explodes many erroneous notions about the electro-magnet very carefully inculcated by old text books. The book will form a valuable addition to electrical literature, and should be within reach of every electrician. The history of the electro-magnet is traced from the time of Sturgeon and Henry, whose work is sketched fully, to the present day. All peculiarities of form and structure are clearly described and illustrated by clear engravings. The principle of the magnetic circuit is fully explained and phenomena hitherto obscurely understood become perfectly clear when interpreted in the new light.

The first lecture contains an historical sketch of the early forms of Sturgeon, Henry, Roberts and others; a discussion of the properties of iron as to magnetic permeability and methods of measuring the same; the effects of hysteresis; and concludes with a recital of a series of facts and fallacies about electro-magnets. This is so concisely put and so highly useful to every electrician that we quote it:

Fallacies.—The attraction of an electro-magnet for its armature varies inversely as the square of its distance from the poles.

The outer windings of an electro-magnet are necessarily less effective than those that are close to the iron.

Hollow iron cores are as good as solid cores of the same size.

Pole pieces add to the lifting power of an electro-magnet.

It hurts an electro-magnet (or, for that matter, a steel magnet) to pull off the keeper suddenly. It is the sudden slamming on that in reality hurts it.

The resistance of the coil of an electro-magnet ought to be equal to the resistance of the battery.

A coil wound left-handedly magnetizes a magnet differently from a coil wound right-handedly. (It is not a question of winding of coil, but of circulation of current.)

Thick wire electro-magnets are less powerful than thin wire electro-magnets.

A badly insulated electr-omagnet is more powerful than one that is well insulated.

A square iron core is less powerful (as Dal Negro says, 18 fold), than a round core of equal weight.

The attraction of an electro-magnet for its keeper is necessarily less strong (one-third, according to Du Moncel), sidewise than when the keeper is in front of the poles.

Putting a tube of iron outside the coils of an electro-magnet makes it attract a distant armature more powerfully.

Facts.—A bar electro-magnet with a convex pole holds on tighter to a flat-ended armature than one with a flat pole does.

A thin round disk of iron laid upon the flat round end of an electro-magnet (the pole end being slightly larger than the disk), the disk is not attracted, and will not stick on, even if laid down quite centrally.

If a flat armature of iron be presented to the poles of a horseshoe electro-magnet the attraction at a short distance is greater, if the armature is presented flankwise than if it is presented edgewise. On the contrary, the tractive force in contact is greater edgewise than flankwise.

Electro-magnets with long limbs are practically no better than those with short limbs for sticking on to masses of iron.

Lecture II treats of general principles of design and construction, closed and open magnetic circuits, magnetic leakage, more fully considering the principle of the magnetic circuit, effects of various forms of pole pieces, containing formulæ for calculating traction, permeability, saturation, the magnetizing power requisite to force a given number of lines of force through a definite magnetic reluctance, etc.

Lecture III treats of winding, effects of size and position of coils, shape of section, distance between poles, position and form of armature, form of pole pieces, quick acting magnets.

Lecture IV treats of electro-magnetic mechanism and fully discusses solenoids. This chapter contains a valuable contribution to the literature of electricity. The action of solenoids, aside from the knowledge that they will suck in an iron core, is so little understood that Prof. Thompson deserves the highest commendation for presenting the results of the work of other scientists and enriching the store of knowledge with his own researches.

The characteristic feature of the treatment of the subject is that the facts and formulæ are presented in a shape that enables them to be intelligently used in practice.

"Dry Goods Economist Year Book" for 1891, has been received.

"Journal of the Institution of Electrical Engineers," issued January, 1891, has come to hand.

"Annual Report of the Postmaster-General of the United States for the Fiscal Year ending June 30, 1890," has been received from the Hon. John Wanamaker with his compliments.

"A Box of Autographs" is Richard Henry Stoddard's account of some of his unique treasures, with *fac-similes* of manuscripts of Addison, Burns, Mrs. Browning, Campbell, Scott, Thackeray, and other worthies. Mr. Stoddard embodies in his article much entertaining literary reminiscence. This article, with other interesting literary and pictorial features, is published in *Scribner's Magazine*, for February.

Electric Mutual Insurance Company.

President Stephen E. Barton, in his first annual report, says:

"Several fires have occurred in electric stations, but nearly all have been traceable to carelessness of construction, or failure to provide any facilities for the extinguishing of fire—faults due wholly to the unusally rapid development of the industry. A more deliberate, permanent and extensive era of construction has set in and the mistakes and neglects of the past are not being repeated.

"Those engaged in electrical development, generally, will not fail to appreciate the good results that will follow, and the fire losses that may be avoided, by the dissemination of practical and valuable ideas pertaining to safety, through the intelligent inspection of its risks by an insurance association devoting itself especially to the electrical business. The excellent results obtained by the factory mutuals have been due to the avoidance of 'normal hazard' by their careful selection of risks, and intelligent inspection of the same, coupled with the interest that each insurer has in the welfare of the companies.

"There is surely no other industry whose best interests can be served to so great a degree by the absence of fire loss as can the electrical; and therefore we feel confident of the wisdom shown in following the lead of those mutual companies whose plans we have adopted and with which we are so agreeably working."

Election of Officers.

The board of directors of the Standard Underground Cable Company, elected at the annual meeting of the company on January 27, met February 2, 1891, in the company's office, Westinghouse building, and organized by electing Joseph W. Marsh, as vice-president and general manager, Frank A. Rinehart, as secretary and treasurer, and Oscar R. Ebel, as auditor. An executive committee was also created, consisting of John H. Dalzell, Mark W. Watson and Robert Pitcairn; the president or vice-president being *ex-officio* members.

Mr. Marsh's advancement from assistant-general manager is a deserved recognition of his able management in the past.

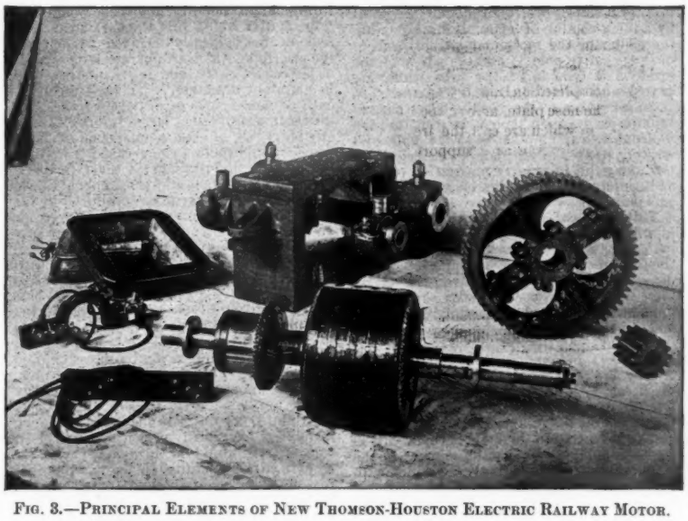


FIG. 3.—PRINCIPAL ELEMENTS OF NEW THOMSON-HOUSTON ELECTRIC RAILWAY MOTOR.

An Electric Light on Wheels.

Manager Charles Atkins, of the Council Bluffs, Ia., telephone exchange, has invented a novel means of distributing incandescent electric light in various parts of his office. His invention was created by the necessity of having a strong light for examining the delicate points of the switchboard, and his desire not to bankrupt the company by calling for a light in front of each section of the board. His device consists of a portable car that travels on a metallic circuit the full length of the switchboard. The track consists of two copper wires that are strung the full length of the room about four inches from the ceiling, and just back of the switchboard. Both wires are connected through a fuse box with the main incandescent circuit. On these wires, which are about four inches apart, travels the car, which is a small wooden affair with four metallic wheels, two of which rest on each wire. A flexible cord having two electric conductors, passes up through the center of the car, and each of the conductors is soldered to the frame of the car. The lamp socket is attached to the other end of the double cord in the usual manner. With this arrangement, the car can be run along the wires with ease, carrying the light wherever needed.

What Bill Said.

The Abbott electric motor will soon be on exhibition at the C. & E. depot. Bill says it will soon be in running order.—*Hammond, Ind., Standard.*

American Projectile Company.

The directors of the Thomson Electric Welding Company have decided to organize the American Projectile Company, with a capital of $500,000, for the manufacture of projectiles for the army and navy departments of the United States government. The articles of incorporation will be prepared at once. The plans of the new factory at Lynn are in readiness, and within 60 days, as heretofore remarked, it is expected that the building will be erected and stocked with the necessary machinery. The present government contracts are to be filled within the ensuing six months. The necessary experimenting has already been done, and the factory will start at once upon the regular manufacture of these projectiles. Rights will be given to the stockholders of the Thomson Electric Welding Company to subscribe at par to the stock of the new Projectile Company, the Thomson Electric Welding Company taking enough stock to carry control. It is understood that a contract has been made with the Kellogg Seamless Tube Company, whose works are at Findlay, O., to supply the Projectile Company with seamless tubes for the manufacture of projectiles.

ELECTRIC LIGHT NEWS

—— The Germantown, Pa., Electric Light Company have built an annex to their plant.

—— At a town meeting held in Danvers, Mass., last week, the town voted to petition the legislature to legalize the action of the town in establishing an electric light plant.

—— Bids will be opened at San Diego, Cal., February 19, for lighting the city with 11 masts carrying six lights of 2,000 candle-power each and 22 single 2,000 candle-power lights.

—— Mr. Kimball, of the Fort Wayne Electric Company, of Fort Wayne, Ind., is in Three Rivers, Mich. He has been called there by the corporation of the city to inspect the plant sold and put in by the Royal Electric Light Company, of Montreal.

—— The chief of the Electrical Bureau of Philadelphia, has submitted his 17th annual report. He suggests city ownership of poles for electric street lighting wires in order that the city may be able to prevent the unnecessary accumulation of wires and poles.

—— On December 30, 1890, the East End Electric Light Company, of Pittsburgh, reported: Number of 16-candle-power lamps equivalent on circuit, 20,134; arc lights on circuit, 430. At the same time 1889, the number of the former was 11,508, and of the latter 385.

—— Wheeling, W. Va., has decided to purchase an electric light plant to be owned and operated by the city. Estimates have been received from the Westinghouse, Thomson-Houston, Western, Fort Wayne and the National Electric companies, varying in amount from $101,250 to $61,000. The matter is now in the hands of the city council.

—— For the last few days customs detectives have been investigating alleged customs irregularities at the port of Halifax, N. S. The biggest haul was made from the Chandler Electric Company, whose entire plant was seized for undervaluation, and only released upon payment to the detectives of a fine of $11,000. The Chandler Electric Lighting Company has the control for lighting the city of Halifax.

—— There is a chance that electricity will supersede the oil lantern in Boston's fire apparatus. Henry Heymann, the engineer of engine 33, has been conducting a series of experiments with this in view. Within a few days two storage batteries will be placed in the wagon used by Chief Webber for a trial. Each will maintain two lamps of six candle-power for 17 hours. When one battery is exhausted the other will be substituted.

—— Mr. B. F. Keith, of the B. F. Keith Theatre Company, Boston, Providence and Philadelphia, intends erecting a large isolated electric light station in Providence, R. I. The power house will be situated on Clement street, and will be one of the largest in Providence. The primary object of this station is to light the new Bijou Theatre, of Providence, with about 800 lights. This play house is now lighted from the central station of the Narragansett Electric Light Company.

A Financial Prediction.

The electric interests are growing at a wonderful rate. *The Daily Financial News* has predicted great things ahead for the Edison General, Thomson-Houston and Westinghouse companies. The former company already pay eight per cent., the Thomson-Houston has also joined the dividend list. The Westinghouse will not stay in the background long, for there is plenty of business and good profit in it, and capital to take advantage of it will not long be wanting.

ELECTRICITY IN TRANSITU—FROM PLENUM TO VACUUM.

(*Continued from page 301.*)

gold leaf electroscope it will be seen that each is charged with positive electricity. But the shading also shows more positive at C than at D, and on connecting C and D with a galvanometer the needle indicates a rush of current from C to D, D being negative to C. The dark space is next brought to such a position that the pole C is well within it (Fig. 8, *b*). A change has now come over the indications. The galvanometer shows a reverse current to that which was seen on the former occasion. C is now negative and D positive, but the gold leaves still tell us both poles are positively electrified.

At a certain position of the dark space, when its edge is on the pole C, Fig. 8, *c*, a neutral state is found at which the gold leaves still show strongly positive electrifications, and no current is seen on the galvanometer. The curves below (Fig. 8, *c*), roughly show the rise and fall of negative and positive current at different parts of the tube, whilst the potential curve keeps positive.

When a substance that will phosphoresce under electrical excitement is introduced into the tube, the position of greatest luminosity is found to be at the border of the dark space, just where the two opposing armies of negative and positive atoms meet in battle array and recombine. Later on I shall refer to this phenomenon in connection with the phosphoresence of yttria.

RADIANT MATTER.

By means of this tube (Fig. 9), I am able to show that a stream of ultra-gaseous particles, or radiant matter, does not carry a current of electricity, but consists of a succession of negatively electrified molecules whose electrostatic repulsion overbalances their electro-magnetic attraction, probably because their speed along the tube is less than the velocity of light. The tube has two negative terminals A, A', close together at one end, enabling me to send along the tube two parallel streams of radiant matter, rendered visible by impinging them through holes in a mica diaphragm on a screen of phosphorescent substance. It is exhausted to a pressure of 0.1 mm. I connect one of the negative poles, A, with the induction coil, and the luminous stream darts along the tube from C to D parallel with the axis. I now connect the other negative pole, giving a second parallel stream of radiant matter. If these streams are in the nature of wires carrying a current they will attract each other, but if they are simply two streams of electrified molecules they will repel each other. As soon as the second stream is started you see the first stream jump away in the direction C E, showing strong repulsion, proving that they do not act like current carriers, but merely like similarly electrified bodies. It is, however, probable that were the velocity of the streams of molecules greater than that of light they would behave differently, and attract each other, like conductors carrying a current. To ascertain the electrical state of the residual molecules in a highly exhausted tube, such as you have just seen, I introduced an idle pole or exploring electrode between the positive and negative electrodes in such a manner that the molecular stream might play upon it. The intention was to ascertain whether the molecules on collision with an obstacle gave off any of their electrical charge. In this experiment (Fig. 10, P=0.0001 mm., or 0.13 M*), it was found that an idle pole, C, placed in the direct line between the positive and the negative poles, A B, receiving in consequence the full impact of the molecules shot from the negative pole, manifested a strong *positive* charge. In a variety of other experiments made to decide this question, the electricity obtained was always found positive on testing with the gold leaf or Lippman's electrometer, and when the idle pole was connected to earth through a galvanometer, a current passed as if this pole were the copper element of a copper-zinc cell, indicating leakage of a current to earth, the idle pole being positive. If, instead of sending this current to earth, the wire was connected to the negative pole of the tube, a much more powerful current passed in the same direction.

THE EDISON EFFECT.

An exactly parallel experiment has been made by Mr. Edison, Mr. Preece, F. R. S., and Professor Fleming, using, instead of a vacuum tube, an incandescent lamp. They found that from an idle pole placed between the ends of the filament the electricity always flowed as if the pole were the zinc element of a copper-zinc cell; having repeated their experiments I entirely corroborate them. I get a powerful circuit in one direction from an idle pole placed between the limbs of an incandescent carbon filament, and one in the opposite direction from an idle pole in a highly exhausted vacuum tube. This discrepancy was extremely puzzling, and I tested, with a similar result, very many experimental tubes made in different ways. The electricity obtained from an idle pole placed between the positive and negative terminals in a highly exhausted tube was always strongly *positive*, and it is only recently that continued experiment has cleared the matter up.

Some of the contradictory results are due to the exhaustion not being identical in all cases. In my vacuum tubes the directions of current between the idle pole and the earth changes from negative to positive as the exhaustion rises higher. Testing the current when exhaustion is proceeding, there is a point reached when the galvanometer deflection—hitherto negative—becomes *nil*, showing that the potential at this point is zero. At this stage the passage of a few more drops of mercury down the pump tube renders the current positive. This change occurs at a pressure of about 2 mm.

After this point is reached, when the induction current is passed through the tube, the walls rapidly become positively electrified, probably by the friction of the molecular stream against the glass, and this electrification extends over the surface of any object placed inside the tube. I will show you how this electrification of the inner walls of the tube acts on the molecular stream at high vacua. In this tube, Fig. 11 (P=0.001 mm. or 1.3 M), are fixed two exactly similar phosphorescent screens C and D; at one end of each is a mica gate, E, E', with a negative pole A, A', facing it. One of the screens, C, is in the cylindrical part of the tube and close to the walls; the other, D, is in the spherical portion, and therefore far removed from the walls. On passing the current the screen D in the globe shows a narrow sharp streak of phosphorescence, proving that here the molecules are free to follow their normal course straight from the negative pole. In the cylindrical part of the tube, however, so great is the attraction of the walls that the molecular stream is widened out sufficiently to make the whole surface of the screen, C, glow with phosphorescent light.

If an idle pole, C, C, Fig. 12 (P=0.0001 mm. or 0.13 M), protected all but the point by a thick coating of glass, is brought into the center of the molecular stream in front of the negative pole A, and the whole of the inside and outside of the tube walls are coated with metal, D, D, and "earthed," so as to carry away the positive electricity as rapidly as possible, then it is seen that the molecules leaving the negative pole and striking upon the idle pole C on their journey along the tube carry a negative charge, and communicate negative electricity to the idle pole.

This tube is of interest since it is the one in which I was first able to perceive how in my earlier results I always obtained a positive charge from an idle pole placed in the direct stream from the negative pole. Having got so far, it was easy to devise a form of apparatus that completely verified the theory, and at the same time threw considerably more light upon the subject. Fig. 13, *a*, *b*, *c*, is such a tube, and in this model I have endeavored to show the electrical state of it at a high vacuum by marking a number of + and — signs. The exhaustion has been carried to 0.0001 mm. or 0.13 M, and you see that in the neighborhood of the positive pole, and extending almost to the negative, the tube is strongly electrified with positive electricity, the negative atoms shooting out from the negative pole in a rapidly diminishing cone. If an idle pole is placed in the position shown at Fig. 13, *a*, the impacts of positive and negatives molecules are about equal, and no decided current will pass from it, through the galvanometer, to earth. This is the *neutral* point. But if we imagine the idle pole to be as at Fig. 13, *b*, then the positively electrified molecules greatly preponderate over the negative molecules, and positive electricity is shown. If the idle pole is now shifted as shown at Fig. 13, *c*, the negative molecules preponderate, and the pole will give negative electricity.

As the exhaustion proceeds, the positive charge in the tube increases and the neutral point approaches closer to the negative pole, and at a point just short of non-conduction so greatly does the positive electrification preponderate that it is almost impossible to get negative electricity from the idle pole, unless it actually touches the negative pole. This tube is before you, and I will now proceed to show the change in direction of current by moving the idle pole.

I have not succeeded in getting the "Edison" current in incandescent lamps to change in direction at even the highest degree of exhaustion which my pump will produce. The subject requires further investigation, and like other residual phonomena these discrepancies promise a rich harvest of future discoveries to the experimental philosopher, just as the waste products of the chemist has often proved the source of new and valuable bodies.

PROPERTIES OF RADIANT MATTER.

One of the most characteristic attributes of radiant matter—whence its name—is that it moves in approximately straight lines, and in a direction almost normal to the surface of the electrode. If we keep the induction current passing continuously through a vacuum tube in the same direction, we can imagine two ways in which the action proceeds; either the supply of gaseous molecules at the surface of the negative pole must run short, and the phenomena come to an end, or the molecules must find some means of getting back. I will show you an experiment which reveals the molecules in the very act of returning. Here is a tube, Fig. 14, exhausted to a pressure of 0.001 mm. or 1.3 M. In the middle of the tube is a thin glass diaphragm, C, pierced with two holes, D and E. At one part of the tube a concave pole, A, is focussed on the upper hole, D, in the diaphragm. Behind the upper hole, and in front of the lower one, are movable vanes, F and G, capable of rotation by the slightest current of gas through the holes.

On passing the current with the concave pole negative, the small vanes rotate in such a manner as to prove that at this high exhaustion a stream of molecules issues from the lower hole in the diaphram, whilst at the same time a stream of freshly charged molecules is forced by the negative pole through the upper hole. The experiment speaks for itself, showing as forcibly as an experiment can show that so far the theory is right.

This view of the ultra-gaseous state of matter is advanced merely as a working hypothesis.

RADIANT MATTER AND "RADIANT ELECTRODE MATTER."

In recording my investigations on the subject of radiant matter and the state of gaseous residues in high vacua under electrical strain, I must refer to certain attacks on the views I have propounded. The most important of these questionings are contained in a memoir by Puluj on "Radiant Electrode Matter and the So-called Fourth State." Dr. Puluj has no authority for linking my theory of a fourth state of matter with the highly-transcendental doctrine of four dimensional space. The greatest difference between Puluj and myself lies in his statement that "the matter which fills the dark space consists of mechanically detached particles of the electrodes which are charged with statical negative electricity, and move progressively in a straight direction." To these mechanically detached particles of the electrodes "of different sizes, often large lumps," Puluj attributes all of the phenomena of heat, force and phosphorescence that I from time to time have described in my several papers. Puluj declares that the phenomena I have described in high vacua are produced by his irregularly shaped lumps of radiant electrode matter. My contention is that they are produced by radiant matter of the residual molecules of gas. In this case we can turn to experimental evidence; therefore I content myself by showing a few novel experiments which demonstratively prove my case. Let me first deal with the radiant electrode hypothesis. Some metals, it is well known, such as silver, gold, or platinum, when used for the negative electrode in a vacuum tube, volatilize more or less rapidly, coating any object in their neighborhood with a very even film. On this depends the well known method of electrically preparing small mirrors, etc. Aluminium, however, seems exempt from this volatility. Hence, and for other reasons, it is generally used for electrodes. If then, the phenomena in a high vacuum are due to the "electrode matter," the more volatile the metal and the greater should be the effect. Here is a tube, Fig. 15 (P. = 0.00068 mm., or 0.9 M), with two negative electrodes, A, A', so placed as to project two luminous spots on the phosphorescent glass of the tube. One electrode, A', is of pure silver, a volatile metal; the other, A, is of aluminium, practically non-volatile. A quantity of "electrode matter" will be shot off from the silver pole and practically none from the aluminium pole; but you see that in each case the phosphorescence, C, C', is identical. Had the radiant electrode matter been the active agent the more intense phosphorescence would proceed from the more volatile pole. A drawing of another experimental piece of apparatus is shown in Fig. 16. A pear-shaped bulb of German glass has near the small end an inner concave negative pole, A, of pure silver so mounted that its inverted image is thrown upon the opposite end of the tube. In front of this pole is a screen of mica, C, having a small hole in the center, so that only a narrow pencil of rays from the silver pole can pass through, forming a bright spot, D, at the far end of the bulb. The exhaustion is about the same as in the previous tube, and the current has been allowed to pass continuously for many hours so as to drive off a certain portion of the silver electrode, and upon examination it is found that the silver has all been deposited in the immediate neighborhood of the pole, whilst the spot, D, at the far end of the tube that has been continuously glowing with phosphorescent light is practically free from silver.

The identity of action of silver and aluminium in the first case, and the non-projection of silver in this second instance, in themselves are sufficient to condemn Dr. Puluj's hypothesis since they prove that phosphorescence is independent of the material of the negative electrode. In front of me is a set of tubes that to my mind puts the matter wholly beyond doubt. The tubes contain no inside electrodes with the residual gaseous molecules, and with them I will proceed to give some of the most striking radiant matter experiments without any inner metallic poles at all. In all these tubes, the electrodes, which are of silver, are on the outside, the current acting through the body of the glass. The first tube contains gas only slightly rarefied, and at the stratification stage. It is simply a closed glass cylinder, with a coat of silver deposited outside at each end, and exhausted to a pressure of two mm. The outline of the tube is shown in Fig. 17. I pass a current, and, as you see, the stratifications, though faint, are perfectly formed. The next tube, seen in outline in Fig. 18, shows the dark space. Like the first, it is a closed cylinder of glass, with a central indentation forming a kind of hanging pocket, and almost dividing the tube into two compartments. This pocket, silvered on the air side, forms a hollow glass diaphragm that can be connected electrically from the outside, forming the negative pole, A; the two ends of the tube, also outwardly silvered, form the positive poles, B, B. I pass the current, and you all see the dark space distinctly visible. The pressure here is 0.076 mm., or 100 M. The next stage dealing with more rarefied matter, is that of phosphorescence. Here is an egg-shaped bulb, shown in Fig. 19, containing some pure yttria, and a few rough rubies. The positive electrode, B, is on the bottom of the tube under the phosphorescent material; the negative, A, is on the upper part of the tube. See how well the rubies and yttria phosphoresce under molecular bombardment, at an internal pressure of 0.00068 mm., or 0.9 M.

A shadow of an objection inside a bulb can also be projected on to the opposite wall of the bulb by means of an outside pole. A mica cross is supported in the middle of the bulb, Fig. 20, and on connecting a small silvered patch, A, on one side of the bulb with the negative pole of the induction coil, and putting the positive pole to another patch of silver, B, at the top, the opposite side of the bulb glows with a phosphorescent light, on which the black shadow of the cross seems sharply cut out. Here the internal pressure is 0.00068 mm. or 0.9 M.

Passing to the next phenomenon, I proceed to show the production of mechanical energy in a tube without internal poles. It is shown in Fig. 21 (P. — 0.001 mm. or 1.3 M). It contains a light wheel of aluminium, carrying vanes of transparent mica, the poles, A B, being in such a position outside that the molecular focus falls upon the vanes on one side only. The bulb is placed in the lantern, and the image is projected on the screen; if I now pass the current you see the wheel rotates rapidly, reversing in direction as I reverse the current.

Here is an apparatus (Fig. 22) which shows that the residual gaseous molecules when brought to a focus produce heat. It consists of a glass tube with a bulb blown at one end and a small bundle of carbon wool, C, fixed in the center, and exhausted to pressure of 0.00076 mm. or 0.1 M. The negative electrode, A, is formed by coating part of the outside of the bulb with silver, and it is in such a position that the focus of rays falls upon the carbon wool. The positive electrode, B, is an outer coating at the other end of the tube. I pass the current, and those who are close may see the bright sparks of carbon raised to incandescence by the impact of the molecular stream.

You have thus seen that all the old "radiant matter" effects can be produced in tubes containing no metallic electrodes to volatilize. It may be suggested that the sides of the tube in contact with the outside poles become electrodes in this case, and that particles of the glass itself may be torn off and projected across and so produce the effects. This is a strong argument, which fortunately can be tested by experiment. In the case of this tube, Fig. 23 (P. — 0.00068 mm. or 0.9 M), the bulb is made of lead glass phosphorescing blue under molecular bombardment. Inside the bulb, completely covering the part that would form the negative pole, A, I have painted a substantial coat of yttria so as to interpose a layer of this earth between the glass and the inside of the tube. The negative and positive poles are silver disks on the outside of the bulb, A being the negative and B the positive pole. If, therefore, particles are torn off and projected across the tube to cause phosphorescence, these particles will not be particles of glass, but yttria, and the spot of phosphorescent light, C, on the opposite side of the bulb will not be the dull blue of lead glass, but the golden yellow of yttria. You see there is no such indication; the glass phosphoresces with its usual blue glow, and there is no evidence that a single particle of yttria is striking it.

Witnessing these effects I think you will agree I am justified in adhering to my original theory that the phenomena are caused by the radiant matter of the residual gaseous molecules, and certainly not by the torn-off particles of the negative electrode.

PHOSPHORESCENCE IN HIGH VACUA.

I have already pointed out that the molecular motions rendered visible in a vacuum

tube are not the motions of molecules under ordinary conditions, but are compounded of these ordinary or kinetic motions and the extra motion due to the electrical impetus. Experiments show that in such tubes a few molecules may traverse more than a hundred times the *mean* free path, with a correspondingly increased velocity, until they are arrested by collisions. Indeed, the molecular free path may vary in one and the same tube, and at one and the same degree of exhaustion. Very small bodies, such as ruby, diamond, emerald, alumina, yttria, samaria and a large class of earthy oxides and sulphides, phosphoresce in vacuum tubes when placed in the path of the stream of electrified molecules proceeding from the negative pole. The composition of the gaseous residue present does not affect phosphorescence; thus, the earth yttria phosphoresces well in the residual vacua of atmospheric air, of oxygen, nitrogen, carbonic anhydride, hydrogen, iodine, sulphur and mercury. With yttaria in a vacuum tube, the point of maximum phosphorescence, as I have already pointed out, lies on the margin of the dark space. The diagram, Fig. 24, shows approximately the degree of phosphorescence in different parts of a tube at an internal pressure of 0.25 mm. or 330 M. On the top you see the positive and negative poles, A and B, the latter having the outline of the dark space shown by a dotted line, C. The curve, D E F, shows the relative intensities of the phosphorescence at different distances from the negative pole, and the position inside the dark space at which phosphorescence does not occur. The height of the curve represents the degree of phosphorescence. The most decisive effects of phosphorescence are reached by making the tube so large that the walls are outside the dark space, whilst the material submitted to experiment is placed just at the edge of the dark space.

Hitherto I have spoken only of phosphorescence of substances placed under the negative pole. But from numerous experiments I find that bodies will phosphoresce in actual contact with the negative pole. This is only a temporary phenomenon, and ceases entirely when the exhaustion is pushed to a very high point. The experiment is one scarcely possible to exhibit to an audience, so I must content myself with describing it. A U-tube, shown in Fig. 25, has a flat aluminium pole, in the form of a disk, at each end, both coated with a paint of phosphorescent yttria. As the rarefaction approaches about 0.5 mm., the surface of the negative pole, A, becomes faintly phosphorescent. On continuing the exhaustion this luminosity rapidly diminishes, not only in intensity, but in extent, contracting more and more from the edge of the disk, until ultimately it is visible only as a bright spot in the center. This fact does not prop a recent theory, that as the exhaustion gets higher the discharge leaves the center of the pole, and takes place only between the edge and the walls of the tube. If the exhaustion is further pushed, then at the point where the surface of the negative pole ceases to be luminous, the material on the positive pole, B, commences to phosphoresce, increasing in intensity until the tube refuses to conduct, its greatest brilliancy being just short of this degree of exhaustion. The probable explanation is that the vagrant molecules I introduce in the next experiment, happening to come within the sphere of influence of the positive pole, rush violently to it and excite phosphorescence in the yttria, whilst losing their negative charge.

LOOSE AND ERRATIC MOLECULES.

I will show you a piece of apparatus that clearly illustrates the cause of phosphorescence at the positive pole. A drawing of this tube is shown in Fig. 26, but let me first explain the effect I expect to obtain, and then endeavor to show the actual experiment.

A C B is a U-shaped tube with terminals, A and B, at each end; D and E are two mica screens covered with a phosphorescent powder, having at F and G other screens with a small slit in front, so as to allow only a narrow beam of charged molecules to pass through. At first the tube is exhausted to a pressure of 0.076 mm. or 100 M, and you see how sharp and slightly divergent is the luminous image on screen D, whilst not a trace of phosphorescence is to be seen on the screen E in the other limb of the tube. Now I push the exhaustion to the highest point short of non-conduction (0.000076 mm. or 0.1 M), and the phenomena change. The initial line of light on D becomes wider and unsteady, whilst at the gate, G, a decided phosphorescence is observable entering the second screen, E. This luminosity diverges to a considerable extent, much more than did the stream of charged molecules observed in the first limb of the tube at the lower exhaustion. This is only to be expected, inasmuch as those sparse molecules which have run the gauntlet of the crowd and have been hunted and buffetted round the corner will have little or no lateral support, but wander to the furthest part of the tube, and altogether behave differently to the orderly procession of molecules at more moderate exhaustion.

THE RESISTANCE OF HIGH VACUA.

This is a subject of deep interest, and one to which I have lately devoted much time. The passage of an induction current at a high vacuum through a tube depends much upon the material of the tube or the substance enclosed within it. Given the same degree of exhaustion, and the same distance between the terminals inside the tube, the E. M. F. necessary to force the current through may vary from 3,000 volts to 20,000 volts, according to the particular material used. Here is a very striking example that will serve to illustrate this phenomenon. Fig. 27 is a double tube joined by a narrow open channel, and therefore in the same state of exhaustion throughout (P = 0.02 mm. or 26 M). Each tube is furnished with a pair of poles, A B, and A′ B′. One tube contains the phosphorescent earth yttria, the other contains finely divided carbon. I first connect the yttria tube, C, to the coil, and place in parallel circuit with it a spark gauge. To begin with, this gauge is set to a gap of 1 mm. (An E. M. F. of 920 volts is necessary to strike across 1 mm. of air; therefore the difference of potential at the terminals inside the yttria tube is 920 volts, and this you perceive is not sufficient to force the current through the tube.) I now gradually open the gauge until the potential of the inner terminals has risen to a point high enough to allow the spark to pass through the tube, making the yttria phosphorescent. The gap is at 7 mm. equal to an E.M.F. of 6,440 volts. I next attach the coil wires to the tube, D, containing the carbon, and the exhaustion in the tubes being the same as before, I repeat the experiment; you now see that the gap has to be opened to 30 mm., equivalent to an E.M.F., of 27,600 volts, before the current will pass through the tube. The fact of whether the vacuum tube contains yttria or carbon makes a difference of 21,160 volts in the E.M.F. required to cause a charge between the terminals.

One other experiment I would like to show in further illustration of this resistance. The idea suggested itself that possibly differences in the material or conductivity of the particular bulbs might influence the results you have just seen. Here (Fig. 28) is a long, cylindrical tube of phosphorescent Bohemian glass, containing a pair of terminals, A B; it also contains a shorter cylinder of glass, C C, brightly silvered inside. The internal pressure is 0.00068 mm. or 0.9 M. The silver cylinder is now at one end of the tube out of the way of the terminals, which, therefore, have phosphorescent glass around them. I turn on the coil and find that the E. M. F. necessary to force the current through, now that the terminals are in a phosphorescent chamber, is 1,380 volts. I slide the cylinder down to the end of the tube so as to enclose the terminals in a metallic silver chamber, and you see the E. M. F. necessary to pass the current rises to 6,440 volts. Metallic silver does not phosphoresce, whilst Bohemian glass phosphoresces very well. It appears that the greater the phosphorescing power of the substance surrounding the poles, so much the easier does the induction spark pass. Surround the poles with Bohemian glass or yttria—two phosphorescent non-conductors of electricity—and the induction spark passes easily; immediately I surround the terminals with a non-phosphorescent conductor the current refuses to pass.

WHAT OCCASIONS PHOSPHORESCENCE?

I should like to interest you in a question that has exercised my mind for some time past. What is it that occasions phosphorescence of yttria and other bodies in vacua under molecular bombardment? So far, I have found this phosphorescence to be an attribute of non-conductors only. We know that in the act of phosphorescence the molecules of yttria are in a state of intense vibration. Each molecule may be viewed as the radiating center of the entire bundle of rays, which, when decomposed by the prism, displays a discontinuous spectrum. We may also suppose that the residual atoms of gas charged with negative electricity give off their electricity on coming in collision with a phosphorescent body, and on their return take up a fresh charge. There is a certain amount of evidence in favor of an electrolytic hypothesis of the passage of electricity through rarefied gases. This has been ably advocated by Professor Schuster in the Bakerian lecture before the Royal Society, March 20, 1890. A molecule of hydrogen gas, for instance, may be made up of one group of atoms of hydrogen having an equivalent of negative electricity inherent in it, and one group of atoms having an equivalent of positive electricity bound up with it. These atoms are also charged with *additional* equivalents of positive or negative electricity, which they carry about as a ship carries its cargo. We are not concerned with the inherent electricity—of which we are ignorant—but with the extra or "cargo" charge. Let us imagine a molecule of hydrogen near the face of the negative pole in a vacuum tube. I turn on the current, and the atoms of the hydrogen molecule are dragged apart. The positive atom is attracted to the negative pole, where the violence of impact, or the discharge of electricity, renders it apparent with evolution of light. The internal luminous layer, which is closely adjacent to the negative electrode, is due, therefore, to the positive atoms rushing to the negative pole, and not, like the glow round the edge of the dark space, to the negative atoms projected from it. The negative atom, on the other hand, is driven violently from the negative pole, in virtue of the mutual repulsion existing between any two bodies similarly electrified, with a velocity varying with the intensity of the electrification and the degree of the vacuum; the more perfect the vacuum the greater the velocity, the atoms flying outwards in straight lines until they meet with an obstacle. Such an obstacle may be a procession of positively charged atoms from the positive pole. In this case the two kinds of atoms mutually discharge each other's cargoes with a display of light. This phenomenon occurs at the margin of the dark space when the vacuum is only moderate; or the obstacle may be produced by the vacuum being so high that the atoms of gas present are too few to form a continuous procession. (*Why* a high vacuum should be non-conductive does not clearly appear, but the fact itself is beyond doubt. It is probably connected with the inability of electrified atoms to leave the poles.) Or, again, the obstacle may be a phosphorescent body like yttria. In this case the negatively-charged atoms deliver up their charge of electricity to the yttria, which is so constituted—perhaps after the manner of a Hertz resonator—that its atoms charge and discharge, vibrating about 550 billion times in a second, and producing waves in the ether of the length, approximately, of 5.74 ten millionths of a millimetre, and occasioning in the eye the effect of citron light.

We are not under the necessity of supposing that this number of hydrogen atoms are driven against the yttria in the second, although even at a high vacuum there are quite enough atoms left in the bulb to keep up such a supply. All that is needed is that a succession of shocks, not necessarily rythmical, may strike the yttria at frequencies which will set up such a number of vibrations just as a series of slow impacts on a gong causes it to emit sound waves of much greater frequency. In a low vacuum only very few atoms can run the gauntlet, among the crowd of inrushing atoms, and those few which succeed in reaching the yttria arrive with much reduced velocity, and so faint is the phosphorescence they set up that it is completely obscured by the brighter phosphorescence of the residual gas. As the vacuum becomes higher, more and more atoms find their way across, and their speed being at the same time accelerated, the phosphorescence becomes intensified. At a good vacuum most of the atoms hit the yttria, their velocity is increased, and the rythmical excitation reaches its maximum.

In applying the electrolytic hypothesis, I have used for illustration's sake the gaseous residue of hydrogen, which is known as a diatomic gas. I have found, however, the phenomena of the dark space, etc., to occur in the vapor of mercury, which is a monatomic gas. This important result induced me to patiently investigate this subject, and the result of one experiment is before you, Fig. 29. The tube is furnished with iluminum terminals, and is so arranged that the induction spark can be kept passing during exhaustion to drive off occluded gases. When at the highest attainable vacuum, the tube is filled with pure mercury by simply raising a reservoir. On applying heat the entire contents of the tube are boiled away and pass down the fall tubes of the pump, exhaustion going on at the same time. When the whole of the mercury has thus been boiled away *in vacuo*, except a little condensed at the upper part of the tube, the results on passing the spark are as follows: When the tube is cold the induction current refuses to pass; on gently heating with a gas-burner the current passes and the dark space is distinctly visible. Continuing the heat so as to volatilize the drops of mercury condensed on the sides, the whole tube becomes filled with a green phosphorescent light, the dark space gets smaller and smaller, and ultimately the negative pole becomes covered with a luminous glow. On allowing the tube to cool the same phenomena ensue in inverse order. The luminous halo expands, showing the dark space between it and the pole, and this dark space gradually grows larger as the tube becomes cooler. The mercury again condenses on the side of the tube, the green phosphorescence grows paler and paler, until at last the induction spark from the large coil refuses to pass.

At first sight this result appears fatal to the electrolytic hypothesis, for if the molecule of mercury contains only one atom, how can we talk of its separation into positive and negative atoms by the electric stress? It must be remembered, however, that we are as yet ignorant of the absolute mass of the atom of any element. All that can be said is that a molecule of free hydrogen becomes halved in combining chemically with certain other elements, whilst a molecule of free mercury does not suffer division on yielding any known compound of mercury; the physical atoms in the one behave as two separate groups, and those in the other as one undivided group. It has been agreed by chemists, for simplicity's sake, and for facilitating chemical calculations, to reduce the units to the lowest term consistent with the avoidance of fractions; we therefore say that the atoms in a molecule of free hydrogen act in chemistry as two separate groups, each of a minimum relative weight of one, whilst those in a molecule of free mercury act as one undivided group of the relative weight 200. But to what number of atoms the 1 and 200 correspond respectively no chemist knows.

To show how intimately chemistry and electricity interlock, I may here remark that one of the latest theories in chemistry renders such a division of the molecule into groups of electro-positive and electro-negative atoms necessary for a consistent explanation of the genesis of the elements. This is so important that I may be excused for digressing a little into this development of theoretical chemistry.

GENESIS OF THE ELEMENTS.

It is now generally acknowledged that there are several ranks in the elemental hierarchy, and that, besides the well-defined groups of chemical elements, there are underlying sub-groups. To these sub-groups has been given the name of meta elements. The original genesis of atoms assumes the action of two forms of energy working in time and space—one operating uniformly in accordance with a continuous fall of temperature, and the other having periodic cycles of ebb and swell and intimately connected with the energy of electricity, Fig. 30. The center of this creative force in its journey through space scattered seeds or sub-atoms that ultimately coalesced into the groupings known as chemical elements. The law which governs the motions of multitudes of men and women in a busy thoroughfare I have applied to the atoms of gas in a vacuum tube. At this genetic stage the newborn particles vibrating in all directions and with all velocities, the faster moving ones would still overtake the laggards, the slower would obstruct the quicker and we should have groups formed in different parts of space. The constituents of each group, whose form of energy governing atomic weight was not in accord with the mean rate of the bulk of the components of that group, would work to the outside and be thrown off to find other groups with which they were more in harmony. In time a condition of stability would be established, and we should have our present series of chemical elements, each with a definite atomic weight—definite on account of its being the average weight of an enormous number of sub-atoms or meta elements, each very near to the mean. The atomic weight of mercury, for instance, is called 200, but the atom of mercury, as we know it, is assumed to be made up of an enormous amount of sub-atoms, each of which may vary slightly round the mean number of 200 as a center.

We are sometimes asked why, if the elements have been evolved, we never see one of them transformed, or in process of transformation, into another? The question is as futile as the cavil that in the organic world we never see a horse metamorphosed into a cow. Before copper, *e.g.*, can be transmuted into gold, it would have to be carried back to a simpler and more primitive state of matter, and then, so to speak, shunted on to the track which leads to gold.

This atomic scheme postulates a to-and-fro motion of a form of energy governing the electrical state of the atom. It is found that those elements generated as they approach the central position are electro-positive, and those on the retreat from this position are electro-negative. Moreover, the degree of positiveness or negativeness depends on the distance of the element from the central line, hence, calling the atom in the mean position electrically neutral, those sub-atoms which are on one side of the mean will be charged with positive electricity, and those on the other side of the mean position will be charged with negative electricity, the whole atom being neutral.

This is not a mere hypothesis, but may take the rank of a theory. It has been experimentally verified as far as possible with so baffling an enigma. Long-continued research in the laboratory has shown that in matter which has responded to every test of an element, there are minute shades of difference which have admitted of selection and resolution into meta-elements, having exactly the properties required by theory. The earth yttria, which has been of such value in these electrical researches as a test of negatively excited atoms, is of no less interest in chemistry, having been the first body in which the existence of this sub-group of meta-elements was demonstrated.

The loss sustained by the Philadelphia and Reading Telegraph Company by the recent storm is estimated at $5,000.

KINDRED INTERESTS

The Walker Electric Company, 50 Broadway, New York, are pushing their electric meter strongly, and the effort is meeting with success. There is something especially valuable about a photographic record of current consumed. The meter is a good one and the Walker Electric Company will, doubtless, be pleased to answer any inquiries.

The Thomson-Houston Electric Company, Boston, have sent us a large volume containing outline maps of the United States, showing the central station plants and electric railways and systems in operation. It is claimed that the facts and figures presented were collected and prepared by a disinterested party. According to the figures shown, the Thomson-Houston Company predominates in both the fields mentioned.

The A. W. Harris Oil Company, Providence, R. I., make a specialty of oils for both internal and external lubrication of steam engines, and dynamo oil for general lubrication of dynamos. Their oils have long been recognized, not only by consumers, but by prominent steam engine builders, to be unexcelled, and their large and increasing sales are their best recommendation. Managers of electric light and power stations who are not already using them would do well to give them a trial.

The Pacific Electrical Storage Company, 220 Sutter street, San Francisco, Cal., are the agents of the Accumulator Company, of this city, for the Pacific Coast. They inform us that they have now on the way 500 "15 L" accumulators to fill present orders. All the accumulator plants they have installed are working satisfactorily. In spite of the high freights to the Pacific Coast, the above company has pushed the storage system so that it is rapidly gaining in favor. They have as much business on hand as they can attend to.

The Electrical Commissioners of the District of Columbia invite communications from firms interested in electric cables, conduits, subways, etc. Also upon the subject of municipal electric lighting, electric transmission of power, etc. Communications received until March 1, 1891. Personal interviews cannot be granted at present.

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ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENTS OF THE UNITED STATES WERE ISSUED ON FEBRUARY 3, 1891.

445,538 Electric signaling device; Saml. J. Burrell and Wm. H. Markland, Brooklyn, assignors to Chas. F. Burrell, New York, N. Y.

445,542 Secondary battery; Henry T. Cheswright, Carcassoune, France.

445,545 Non-interference signal box; Moses G. Crane, Newton, Mass.

445,546 Electric arc lamp; James W. Easton, New York, N. Y., assignor to P. Minturn Smith, Plainfield, N. J., and Wm. D. Ferry, Brooklyn, N. Y.

445,549 Mast-arm for electric lights; Geo. Fitch, Sharpsburg, Pa.

445,564 Automatic circuit-closing device for railroad signals; Irvin W. Loy and Richard O'Toole, Mechanicstown, assignors of one-third to John E. Mathews, Baltimore, Md.

445,594 Electric conductor support; Chas. Foster and William H. Bevis, Cincinnati, O.

445,623 445,624 Electric motor; Francis J. Patten, New York, N. Y., assignor, by mesne assignments, to the Patten Alternating Motor Co., of New Jersey.

445,634 Contact device for electric railways; Edw. M. Bentley, New York, N. Y.

445,636 Electrical medical apparatus; Josephus C. Chambers, Detroit, Mich.

445,648 Apparatus for electric branding; Wm. Cannell, Hartford, Conn.

445,653 Electric semaphore; Frederick Stitzel and Chas. Weinedel, Louisville, Ky., assignors to the American Semaphore Co., same place.

445,654 Regulator for electrically propelled vehicles. 445,841 Coupling for the trolley wires of electric railways; Sidney H. Short, Cleveland, O., assignor to the Short Electric Railway Co., same place.

445,674 Electric railway; Rudolph M. Hunter, Philadelphia, Pa., assignor, by mesne assignments, to the Thomson-Houston Electric Co., Boston, Mass.

445,686 Cut-out for incandescent lamps; Turner D. Bottome, New York, assignor to John B. Tibbits, Hoosick, N. Y.

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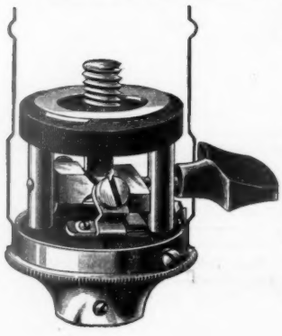

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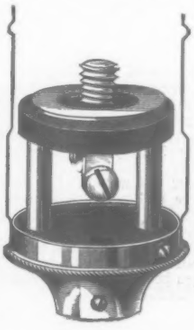

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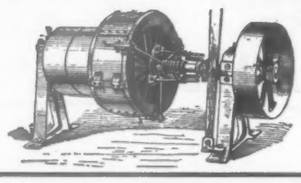

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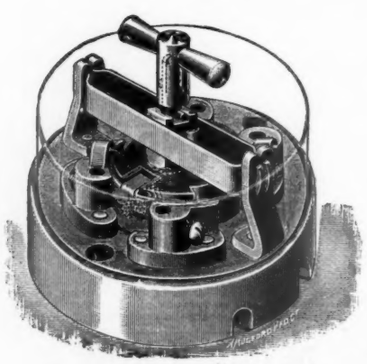

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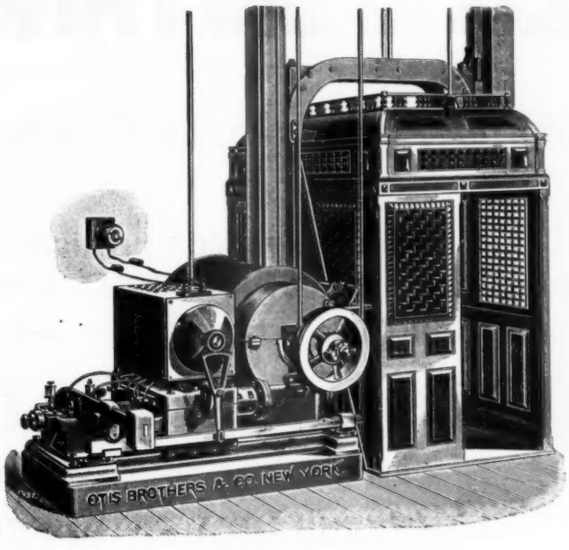

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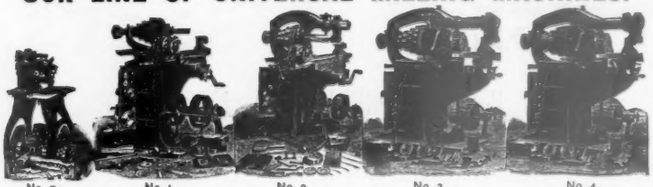

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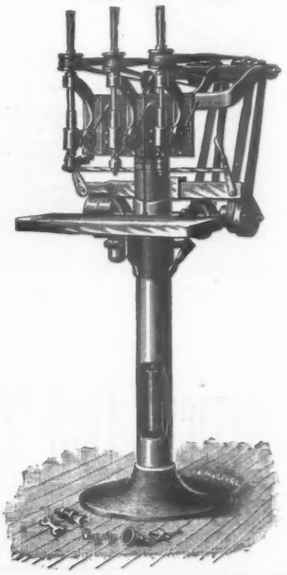

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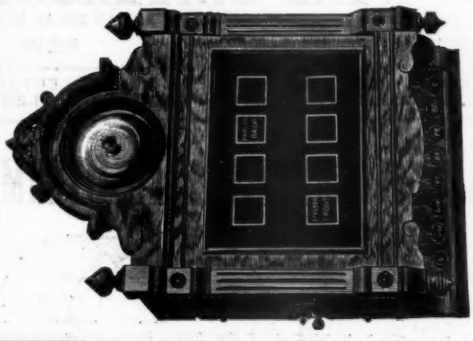

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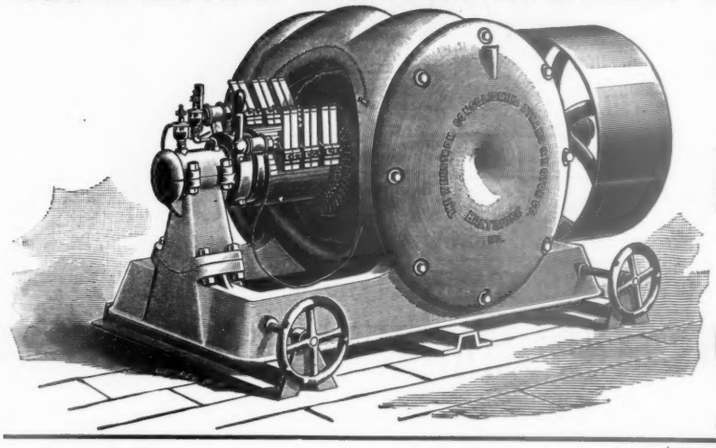

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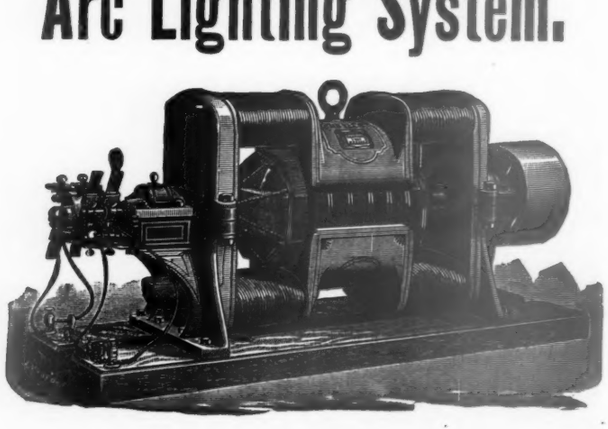

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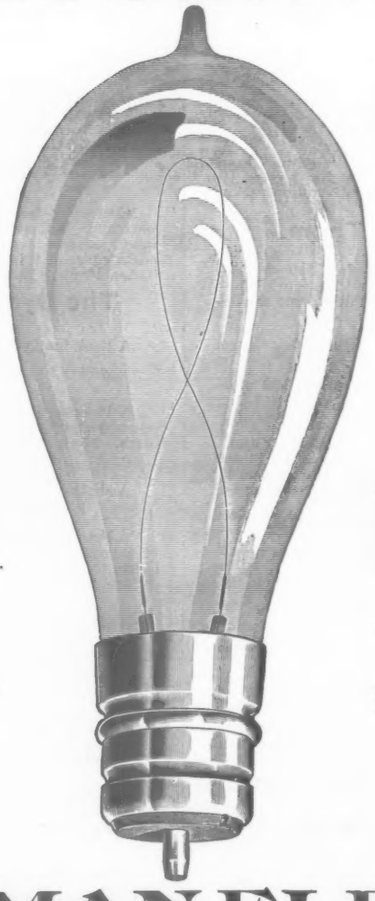

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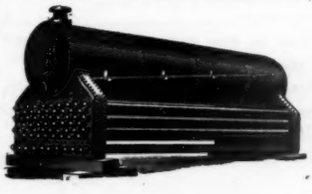

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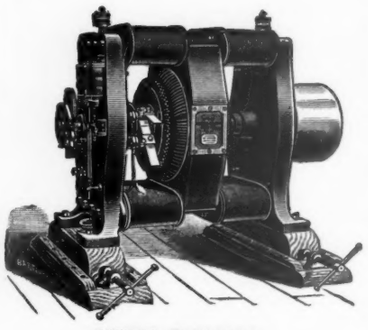

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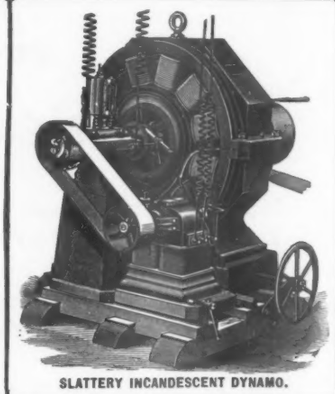

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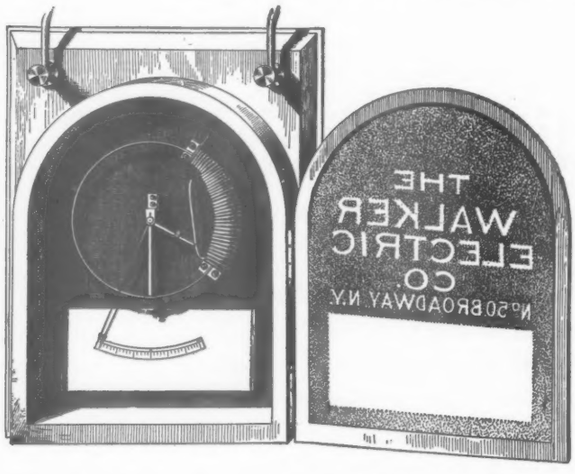

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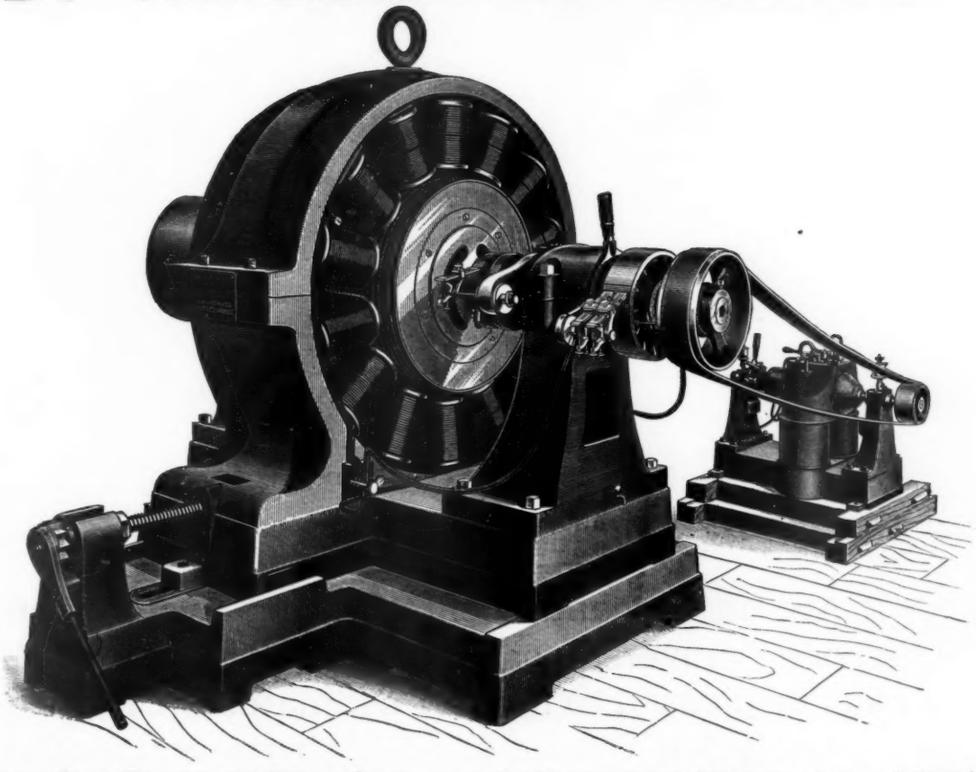

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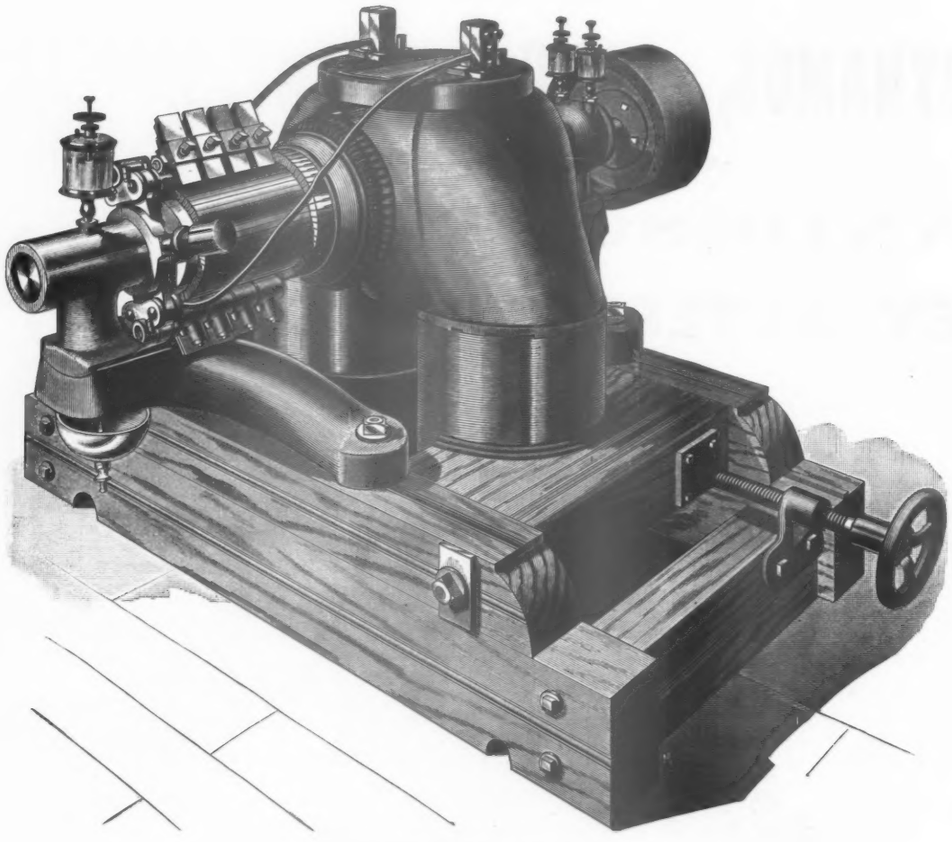

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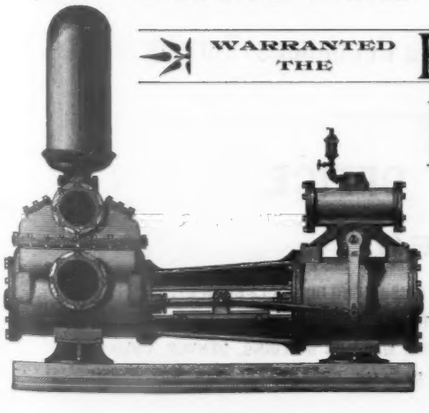

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GENERAL ELECTRIC CO'S

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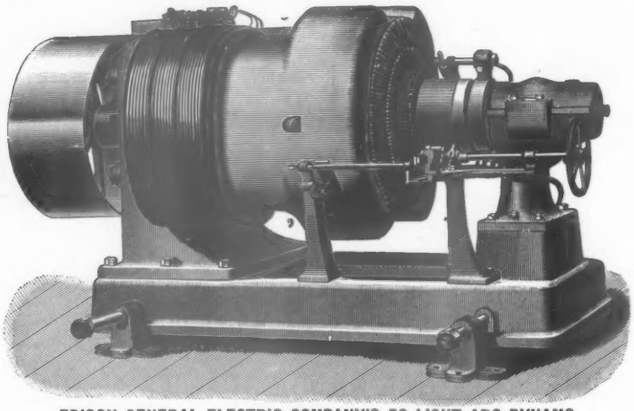

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Simple and Strong Mechanically.

Large, Well Balanced, Well Ventilated Armature.

Sectional Field Windings.

Regulation Automatic, Regulator Simple and on the Machine.

No Extra Circuits, No Wall Resistance.

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1,200 and 2,000 Candle-Power. Lamps for 7 or 14 hours Continuous Burning as Desired.

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SOUTHERN DISTRICT, 10 DECATUR STREET, ATLANTA, GA.

THE "SAMSON" BATTERY.

"AS ITS NAME IS, SO IS ITS STRENGTH."

This Circular is published with the expectation that all users of Open-circuit Battery will carefully peruse its contents; especially those who appreciate the experience of their trustworthy co-workers.

MOST POSITIVE AND CONVINCING EVIDENCE!

The Electric Gas Lighting Co. herewith presents a lot of extracts from letters recently received, from its customers, stating their opinions as to the merits of the SAMSON Battery after from one to three years' use.

Please to note the variety of uses to which the cells have been put, and the results thereof. We think these letters establish the fact that the SAMSON is the best and most economical open-circuit battery made. What say you? Was ever such a VOLUME OF POSITIVE EVIDENCE presented as to the superior merits of an open-circuit battery? If these letters shall be the means of inducing battery users to give the SAMSON a trial, we shall be entirely satisfied, since we have found that those who once try it continue to use it.

MR. P. L. WATSON, SUPERINTENDENT OF FIRE DEPARTMENT, BROOKLYN, N. Y., says: "I would state that in twenty years' experience and use of batteries, *I have never found one that could equal the* SAMSON *for open-circuit work.* I have replaced all local and open-circuit (carbon) batteries (some 500) with it, cell for cell. One circuit, attached to vibrating buzzer, was left closed twenty-seven days constantly working the buzzer without running the battery down."

THE CALIFORNIA ELECTRICAL SUPPLY AND CONSTRUCTION CO., OF SAN FRANCISCO, CAL., state: "*There is no battery made that will equal the* SAMSON. We supply several manufacturers of gas engines for exploding gas, making 150 to 175 sparks a minute. These people have used all kinds of batteries, *but they stay with the* SAMSON. We have also fitted a number of Kidder's Medical Batteries with the SAMSON with the very best results."

MESSRS. EDWARDS & CO., MANUFACTURING ELECTRICIANS, NEW YORK CITY, write: "We have found the SAMSON Battery a very efficient one for open-circuit work, and cheerfully recommend the same."

MR. F. N. CRANE, OF NEWARK, N. J., writes us: "Having used the SAMSON Battery during the past year, I emphatically endorse your claims for them, *and heartily recommend them to all who want the best.*"

MR. FRANK KITTON, PRACTICAL ELECTRICIAN, BUFFALO, N. Y., writes us: "My experience with the SAMSON Battery has been most satisfactory. *It is the best battery for electric gas lighting, telephone transmitter and similar work, that I have ever seen.* Its low internal resistance allows it to furnish nearly twice the current obtained from the ordinary sal-ammoniac battery, which, in brief, commends it for many purposes. *Its recuperative powers are excellent.*"

MR. EDWARD H. CROSBY, OF CROSBY DRY BATTERY FAME, writes: "I take great pleasure in relating my experience with the SAMSON battery, which dates from the time it was first placed on the market in Boston. In all the trying work to which it has been subjected during that time, I cannot chronicle a single failure to meet all claims made for it, and some of the tests to which it has been put have been tremendous. *I consider it unequalled.*"

MR. W. W. SPLANE, SUPT. TEL. DEPT. NAT. TRANSIT CO., BRADFORD, PA., writes: "I prefer the SAMSON battery to all others of the Leclanche form."

MR. W. G. REGGS, MANAGER OF TEL. EXCH. MERIDEN, CONN., writes: "I can but add my testimony to the great working qualities of the SAMSON battery. It is the best I ever handled."

GOOD WORDS FOR THE GREAT FRENCH BATTERY.—CONTINUED.

Prof. C. F. Brackett, of Princeton College, reports: "I have carefully measured and compared the SAMSON Battery with the Leclanche (Gonda Disque). The plotted curves (see printed report) show at a glance, when understood, the relative superiority of the SAMSON to the Leclanche. Careful reference to the figures and the curves which represent them will show that where the two batteries are tested in competition, being fresh, the difference in favor of the SAMSON is about thirty per cent. It is not quite as much at the end of the first hour of continuous working, but it is very decidedly in favor of the SAMSON. The results of the measurements here given in detail fairly represent many others which have been made with other cells of both SAMSON and Leclanche, which have extended over a period of several weeks. In these experiments the batteries have been worked on circuits varying from ten ohms to two ohms, and in every case the results have been decidedly in favor of the SAMSON. I have no hesitation in saying that the SAMSON Battery is the best one for open-circuit work, such as is required in household service and for telephone transmitters, with which I am acquainted."

THE REDSTONE ELECTRIC CO., EVAN JOHNSON, SUPT., UNIONTOWN, PA., say: "Regarding the SAMSON Battery we can only speak in praise. Have used several hundred during the past two years, and *none have yet gone to the hospital!* What their future life may be is yet for us to find out! We have fifty No. 1 cells that have been at work *every three minutes for ten hours a day for two years!* They have, besides this, been on closed circuit on three separate occasions for twenty-five minutes, for three hours and for eighteen hours! We re-charged them after the last grounding seven months since. *The original zincs are still in use.* We now use no other form of open-circuit cell."

MR. E. M. CARHART, ELECTRICAL EXPERT AND DEALER, PROVIDENCE, R. I., says: "I began using the SAMSON Battery more than two years ago, giving them very severe tests, *and became convinced of their great efficiency for open-circuit work*, since which have used nearly 1,000 with perfect satisfaction."

MR. G. L. CLARY, OF BRATTLEBORO, VT., writes us: "I have used the SAMSON Battery for two years on all kinds of electrical plants, particularly gas lighting and annunciator work, and my experience has convinced me that the SAMSON *takes the lead of all open-circuit batteries.* I have had the battery grounded for three days, and with proper attention and care, have brought them out as good as ever by actual test of the Warner Gauge."

THE NEW ENGLAND FIRE AND HEAT REGULATOR CO., BOSTON, writes: "We are pleased to say that from the hundreds we have purchased of you they have always given the best of satisfaction, and we consider the SAMSON *the best battery in use for our business.*"

MESSRS. J. H. COGAN & CO., STEAM HEATING, PLUMBING AND ELECTRICAL FITTERS, AUGUSTA, ME., say: "We have used the SAMSON Battery for over two years, and they *are giving the best of satisfaction.* We have one job where the batteries have been in a year, and they seem as strong now as ever. *Have not touched them since they were put in.*"

MR. T. F. EMMENS, SECRETARY, THE THERMO-ELECTRIC HEAT REGULATING CO., NEW YORK CITY, writes us: "The SAMSON Battery has given such satisfaction that we take great pleasure in testifying that *we consider it the very best battery in the market*—for which reason (having tested many others) *we have adopted it altogether for our Heat Regulator.*"

MR. J. B. YEAKLE, GEN. MGR. AM. DIST. TEL. CO., BALTIMORE, MD., writes: "Our experience with the SAMSON confirms my impressions when we first examined it. *We have the fullest confidence in it*, and certainly less trouble than with either of the many chloride of ammonium elements in use at various former periods."

MR. C. M. GODDARD, ELECTRICIAN, AT PRESENT SECRETARY N. E. INS. EXCH., BOSTON, writes: "I wish to add my testimony in favor of the SAMSON Battery, especially for gas lighting work; *it certainly is the most satisfactory, and, in the end, the cheapest battery I have ever handled*, and thus far I have yet to discover a single fault in it."

THE TUCKER ELECTRICAL CONSTRUCTION CO., 14 WHITEHALL ST., N. Y. CITY, writes: "We regard the SAMSON as the best open-circuit battery we have yet been able to obtain. *They have shown remarkable results for power and longevity.*"

MESSRS. A. H. AND E. W. ABBE, HARDWARE, CUTLERY AND ELECTRICAL GOODS, NEW BRITAIN, CONN., say: "We have used a great many of the SAMSON Batteries, and find them satisfactory; and, in our opinion, they are *the best open-circuit battery we have ever used.*"

MESSRS. AUSTIN BROS., OF STOCKTON, CAL., speak out as follows: "*We guarantee all our electrical work, and use the SAMSON Battery!* Two years' use has demonstrated its *superiority over all others.* The cells are powerful, and have wonderful recuperative qualities."

MR. GEO. W. STONE, OF WILMINGTON, DEL., under date of Dec. 23, 1890, writes: "We have used and sold your SAMSON Battery with the very best results. *None have ever given any trouble nor caused any complaints.* Some are doing service on gas lighting that were put in two years ago and still seem to be as strong as ever. Those who have used them *ask for them when buying again.* I could tell you an instance of their remarkable life on a short circuit that seems almost incredible."

MESSRS. J. U. BURKETT & CO., WASHINGTON, D. C., under date of Jan. 5, 1891, writes: "We have used the SAMSON Battery and find that it fulfills all claims made for it for gas lighting. *We find nothing better and expect to continue using the same.*"

MR. J. W. BRAID, OF NASHVILLE, TENN., says: "Allow me to say that *there is no other open-circuit battery that can take the place of the* SAMSON. By the way, if I mistake not, I was the first party to purchase it, as being in Boston I took a few cells from the first lot you had imported, a part of which you were working at the Mechanics' Fair in Boston.

SAVES TWICE ITS COST EACH YEAR IN EXPENDED CARE AND ATTENTION.

Mr. Geo. L. Batchelder, Electrical Contractor, Bloomington, Ill., writes us: "I have over 200 SAMSON Batteries in use on Electric House service, such as Bells, Annunciators, Gas-lighting and Furnace Regulators, and have had **no instance of any battery giving out.** I am using only one cell for bells where I formerly used two of other forms of Sal-Ammoniac cells. Have had two gas lighting plants short circuited, one about twenty-six hours, after which I washed the carbons, put them back into the old solution, and when connected could work the automatic burners. In the other case, the ground continued from 11 A.M. to 2.30 P.M., when in ten minutes after relieving circuit I could light the gas from the pendants, and in two hours could work the automatics. **Did nothing to this battery, and it is doing good work yet!** This was a five cell battery, No. 2. Am using twelve cells on City Fire Alarm (open-circuit) of nine miles, No. 8 Galvanized Iron Wire; there is quite an escape, as the line runs under trees for about one-third its length. **Have had two of these cells on since April 1, 1889, and they are still about as good as new.** I had to renew the battery on this line while using Leclanche, about seven or eight months, and some of the cells oftener. **The above are facts which are better than theory or laboratory tests."**

MR. W. EDWARD PLATT, ELECTRICAL CONTRACTOR AT AUGUSTA, GA., writes: "I believe I was among the first of your customers in the South to handle and use the SAMSON Battery. I have never seen or used a battery that gives the satisfaction and that equals it; hence, I recommend none other. It is the Battery for all seasons and climates, warm or cold, and too much praise cannot be given it."

MESSRS. GAINES & GLOVER, OF RICHMOND, VA., write: "Every SAMSON cell sold by us has given perfect satisfaction. We have not heard the first complaint."

MESSRS. CHAS. H. FAGE & CO., CONSTRUCTING ELECTRICIANS, WORCESTER, MASS., say: "We have used 800 to 1,000 of the SAMSON Battery during the past two and half years on our electric gas lighting systems, and never used or saw their equal for producing spark and for staying qualities."

MR. CHAS. B. CHAPMAN, OF NORWICH, CONN., says: "I consider the SAMSON the best open-circuit battery that I ever seen, and I have tried a number of the other makes. Shall never use any other style as long as I can procure the SAMSON, which has, indeed, been properly named."

MESSRS. CHANDLER & BARBER, HARDWARE AND ELECTRICAL GOODS, BOSTON, write us: "We have sold quite a number of SAMSON Batteries, and have not heard a single complaint."

MR. J. H. SESSIONS, JR., OF WINSTED, CONN., writes: "I have used the SAMSON Battery since the first you had, and have several now that have been in continual use ever since. Though I have run them down several times, I only have to clean out the jars, dry the porous cup and put them back, *when they are just as good as new. They beat any battery I ever saw;* would not use any others. I have forty-five in my house and barn on bells, electric gas lighting, burglar alarm, etc., *and all work splendidly.*"

MESSRS. G. W. BARNES, ELECTRICIAN, WORCESTER, MASS., speaks as follows: "Please send me fifty No. 1 SAMSON Batteries, *via* Boston and Albany Freight. I wish to say that after twelve years' experience with various kinds of open-circuit batteries, *I consider the* SAMSON *one of the very best.* I have never seen a battery stand up after a long continued ground equal to it, and I have used hundreds of them. *I have used them on the hardest kind of work possible for any battery*, viz, gas lighting work, and the battery that will stand the test there is a good one."

MR. A. C. BROWN, PROPRIETOR TELEPHONE EXCHANGE, MONTPELIER, VT., writes us: "I have found the SAMSON to combine more good qualities than any other kind of battery I have tried. They are strong, quick in action and durable, and require less care than most others, rendering them *a desirable battery for telephone, bell or gas lighting purposes.*"

NOTICE.—We respectfully suggest to Battery makers who are ambitious to obtain, in some way, a cell to compete with the SAMSON, and especially to those who are inclined to imitate this great French battery, that we hold three United States Letters Patent upon it, and that we shall be very likely to call upon the United States Courts for relief if they persist in interfering with our business by infringing these patent rights. While we cannot blame certain parties for desiring to own better cells than they now handle, we must insist that they keep upon their own side of the fence. It will, we believe, be cheaper and better for all parties.

SEND FOR CIRCULARS, PRICE-LISTS, ETC.

THE ELECTRIC GAS LIGHTING CO., BOSTON, MASS.

For Sale at Lowest Prices, in New York City, by

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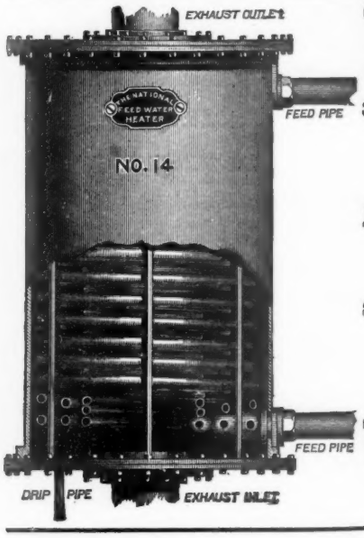
The attention of Electric Light Companies is called to our new, high-resistance INSULATING TUBING, offered at very low prices.

Sole makers of BATTERY CELLS under William Kiel's Patent, the most reliable and satisfactory cell on the market.

Hard Rubber Articles of every Kind and Description Manufactured.

CORRESPONDENCE SOLICITED. ESTIMATES FURNISHED.



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Seventeen sizes Manufactured, 8 to 2,000 Horse Power Capacity. Heats the Water for the Boilers up to 206° to 212° F.

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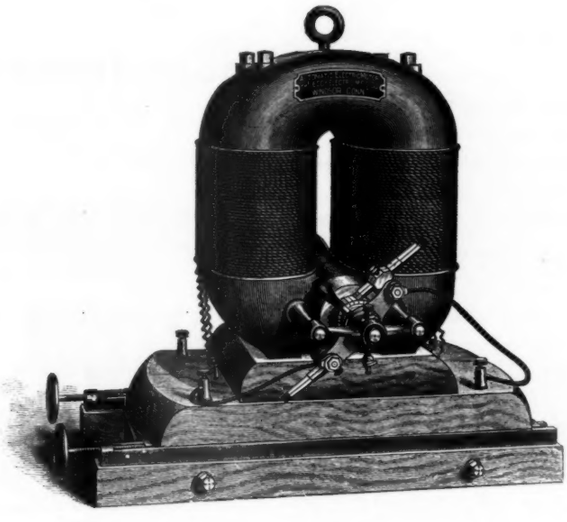

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IMPROVED + CANDEE + WIRES.

These Wires are so well known to the Trade that CONVINCING arguments are not necessary. Everybody knows what they are. Send your orders to us when you want the greatest moisture and acid-proof, or the King of Weather-proof Wires.

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Ball High Speed Automatic Cut-off Engines

MANNING VERTICAL TUBULAR BOILERS,

Complete Steam Plants Furnished and Erected.

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Complete Steam Plants for Electric Light and Power.

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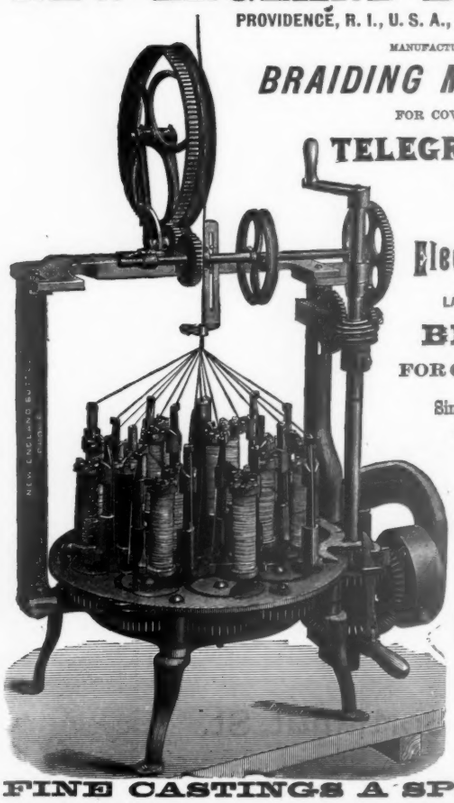

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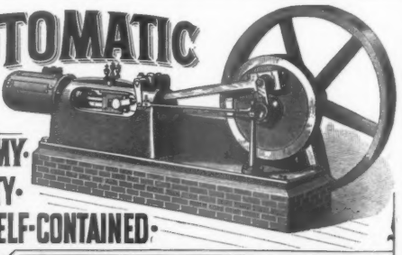

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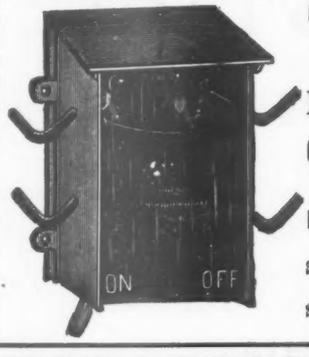

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This Battery Used for

FIRE-ALARM TELEGRAPHS,
POLICE SIGNAL WORK,
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BURGLAR ALARMS,
TELEGRAPHING,
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E. M. F., 1 volt. Int. Rest., 3 ohms,

The Special Gravity for

CHARGING STORAGE CELLS TO RUN
PHONOGRAPHS,
SEWING MACHINES,
ROTARY FANS,
TURN TABLES,
SMALL CANDLE-POWER LAMPS, Etc.

E. M. F., 1.1 volts. Int. Rest., about ¾ ohm.
Current, from 1 to 1½ amperes.

Clean, Cheap and Effective.

WILL RUN ONE YEAR
WITHOUT RENEWAL.

ONE TRIAL will convince you of its Merits.

We also handle 25, 75, 125, 150 and above ampere-hour Storage Cells for all kinds of work, in rubber or Glass Cells. Also a General Line of Supplies.

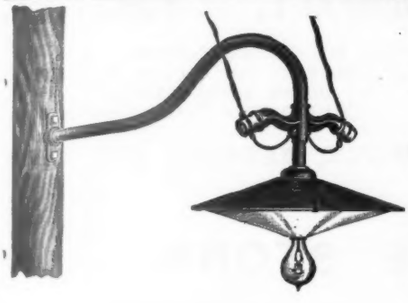
SEND FOR CIRCULARS. Patented Nov. 27, 1888. SEND FOR CIRCULARS.

WARNING TO THE PUBLIC.

A Galvanic Battery called the "Hussey Battery" has been put upon the market and is being sold, which, we are advised, embodies the invention upon which we have secured protection by Letters Patent.

This is to warn the public against the manufacture or use of galvanic batteries employing a porous cup with a zinc electrode dipping into the cup, as secured to us by Letters Patent, as it is our purpose to enforce our rights under the said Letters Patent, and to prosecute all infringers of the same.

GETHINS ELECTRICAL MANUFACTURING COMPANY, 620 Atlantic Ave., BOSTON, MASS.



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ESPECIALLY DESIRABLE FOR STREET AND STORE LIGHTING.

A NECESSITY TO EVERY LIGHTING CO. ✳ ALL OUTSIDE PARTS OF INSULATING MATERIAL.

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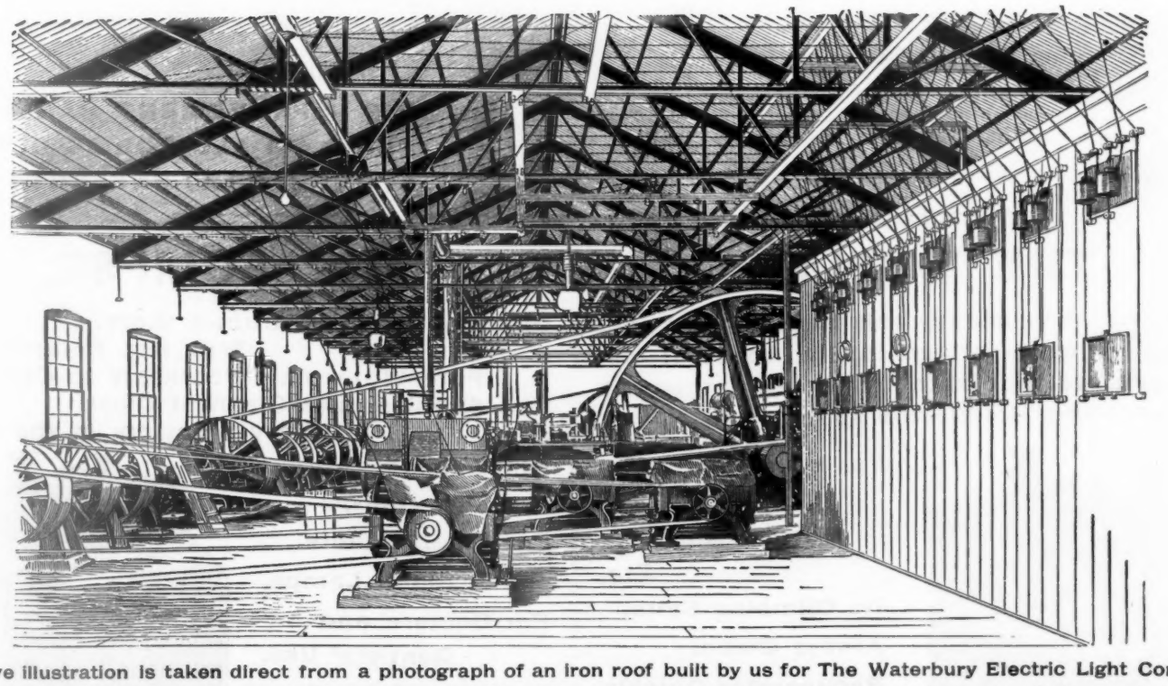
ANY VOLTAGE. CAPPED FOR ANY SOCKET.

BERNSTEIN ELECTRIC CO.

620 ATLANTIC AVENUE, BOSTON, MASS.

THE BERLIN IRON BRIDGE CO.



The above illustration is taken direct from a photograph of an iron roof built by us for The Waterbury Electric Light Company, Conn. The side walls are of brick and the roof is of iron, the floor being of asphalt, making one of the most complete and perfect electric light stations to be found anywhere in the United States.

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PRINCIPAL OFFICE,
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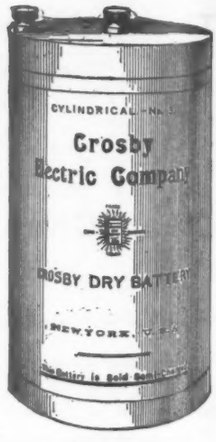
FOR OPEN CIRCUIT WORK.

ELECTRO-MOTIVE FORCE, 1.55 VOLTS. CURRENT, 1 TO 15 AMPERES.

RECTANGULAR, CYLINDRICAL, TELEPHONE.

MADE IN ALL SHAPES AND SIZES.

RECUPERATE OFTENER AND QUICKER THAN ANY OTHER.



NEAT. = CLEAN. = EFFECTIVE. = SIMPLE. = COMPACT. = PORTABLE.

IT IS THE BEST ON THE MARKET.
IT HAS MORE ADVANTAGES THAN ANY.
IT IS SOLD SEMI-CHARGED.
IT DOES NOT DIE ON THE SHELF.
IT IS NOT AFFECTED BY TEMPERATURE.
IT IS NOT DESTROYED BY SHORT CIRCUIT.
IT IS THE MOST RELIABLE.
IT PERFORMS THE MOST WORK.

FOR TELEPHONES, ANNUNCIATORS, GAS LIGHTING, HOUSEWORK, MEDICAL PURPOSES.

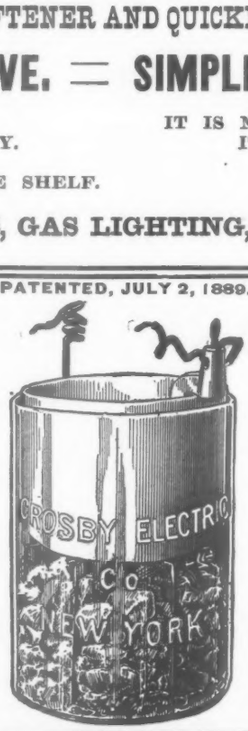
PATENTED, JULY 2, 1889.

THE HUSSEY BLUE STONE.

The Only Blue Stone Battery that can be used for open circuit work.

No Consumption of Blue Stone when not in use.

For Charging Storage Batteries, Running Sewing Machines, Small Incandescent Lamps, Fans, Dental Machines, Telegraphing.



Can be completely recharged without dismounting.

No Deposit of Copper on Zinc.

Gives 10 Times the Current of Any.

For Running Motors.

For All Uses.

THIS IMPROVEMENT CAN BE APPLIED TO ALL FORMS OF BLUE STONE JARS AT PRESENT IN USE.

THE DUPLEX.

Its two cells occupy only the space of one, thereby giving a voltage in the space of one cell, equal to that obtained by any other two cells requiring double the space.

For Housework,
Bells,
Burglar Alarms,
Etc.

No Climbing Salts.

Always Clean.

Recuperates Quickly.

Large Zinc Surface.

Is rapidly taking the place of all other Open Circuit Liquid Batteries.

THE ECLIPSE.

Intended for Close Circuit Work.
Will Not Polarize.
Pure Water only Necessary to Charge It.
The Simplest and Cleanest Close Circuit Battery in the World.

No Fumes.

No Odor.

For Small Motors.

Small Lamps.

For Doctors' and Dentists' Use.

Induction Coils, Etc., and all purposes where a Constant Current is required for continuous or intermittent work.